UNCLASSIFIED

AD 267 595

Reproduced
by the

ARMED SERVICES TECHNICAL INFORMATION AGENCY
ARLINGTON HALL STATION
ARLINGTON 12, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

267 595

SECURITY INFORMATION

AFSWP 126A

UNDERGROUND EXPLOSION TESTS

APPENDIX A

SUPPLEMENTARY

SKEW STRUCTURES

PROGRAM



SACRAMENTO DISTRICT

CORPS OF ENGINEERS

U. S. ARMY

SACRAMENTO, CALIFORNIA

SECURITY INFORMATION

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or revelation of its contents in any manner to an unauthorized person is prohibited by law.

UNDERGROUND EXPLOSION TESTS

APPENDIX A

SUPPLEMENTARY

SKEW STRUCTURES

PROGRAM

Copy No. 13 of 25

Department of the Army

Corps of Engineers

Sacramento District Office

1 March 1952

TABLE OF CONTENTS

Paragraph		Page
1	Introduction	1
2	Authorization	1
3	Objectives	1
4	Cooperating Agencies	2
5	Description of the Area	3
6	Laboratory Soil Tests	4
7	Target Fabrication	5
8	Charge	7
9	Target Preparation	7
10	Data	9
	References	11

PLATES

No.	Title
I	Test Site Location
II	Charge Locations
III	Targets - Plans and Sections
IV	Round S-2 - Plans and Sections
V	Round S-2 - Target R-5 Crack Patterns and Wall Deformations
VI	Round S-2 - Target R-2 Crack Patterns and Wall Deformations
VII	Round S-2 - Target R-3 Crack Patterns and Wall Deformations
VIII	Round S-2 - Target R-1 Crack Patterns and Wall Deformations
IX	Round S-2 - Target T-3 Crack Patterns and Wall Deformations
X	Round S-2 - Target T-2 Crack Patterns and Wall Deformations
XI	Round S-2 - Target T-1 Crack Patterns and Wall Deformations
XII	Round S-3 - Plans and Sections
XIII	Round S-3 - Target R-4 Crack Patterns and Wall Deformations
XIV	Round S-3 - Target R-7 Crack Patterns and Wall Deformations
XV	Round S-3 - Target R-6 Crack Patterns and Wall Deformations

PLATES

No.	Title
XVI	Round S-3 - Target T-7 Crack Patterns and Wall Deformations
XVII	Round S-3 - Target T-6 Crack Patterns and Wall Deformations
XVIII	Round S-3 - Target T-5 Crack Patterns and Wall Deformations
XIX	Replacement Point Layout

-o-

FIGURES

No.	Title
1	Triaxial Shear Tests
2	Concrete Compression Tests
3	Concrete Beam - Flexual Test
4	Concrete Beam - Flexual Test
5	Concrete Beam - Flexual Test
6	Summary of Tension Tests Steel Reinforcement Bars
7	Summary Survey Data Round S-2 - Target R-5
8	Summary Survey Data Round S-2 - Target R-3
9	Summary Survey Data Round S-2 - Target R-2
10	Summary Survey Data Round S-2 - Target R-1
11	Summary Survey Data Round S-2 - Target T-3
12	Summary Survey Data Round S-2 - Target T-2
13	Summary Survey Data Round S-2 - Target T-1
14	Summary Survey Data Round S-3 - Target R-4
15	Summary Survey Data Round S-3 - Target R-6
16	Summary Survey Data Round S-3 - Target R-7
17	Summary Survey Data Round S-3 - Target T-7
18	Summary Survey Data Round S-3 - Target T-6

FIGURES

No.	Title
19	Summary Survey Data Round S-3 - Target T-5
20	Target Movements Relative to Center Line of Charge Round S-2
21	Target Movements Relative to Center Line of Charge Round S-3
22	Field Soil Tests

PHOTOGRAPHS

NO.	SUBJECT
1	Round S-2 - Targets Prepared for Detonation - Crater
2	Round S-3 - Detonation - Crater
3	Round S-2 - Target R-1
4	Round S-2 - Target R-2
5	Round S-2 - Target R-3
6	Round S-2 - Target R-5
7	Round S-2 - Target T-1
8	Round S-2 - Target T-2
9	Round S-2 - Target T-3
10	Round S-3 - Target R-4
11	Round S-3 - Target R-6
12	Round S-3 - Target R-7
13	Round S-3 - Target T-5
14	Round S-3 - Target T-6
15	Round S-3 - Target T-7

1. Introduction. ~~This report presents~~ data secured from two detonations at the Dry Clay site of the Underground Explosion Test Programs using 0.2 scale, buried, open-box and hollow cubical type reinforced concrete target structures. Concomitant data are also included. The shots were part of a large number of tests in clay and in other types of soil, and in rock, which are described in three booklets, "Underground Explosion Tests", issued by the Protective Construction Branch, Engineering Division, Office of the Chief of Engineers. The tests reported here are supplementary to those described in the booklet entitled, "Program A-Tests in Soils", and did not include the instrumentation or dust phases of the program mentioned therein.

2. Authorization. These tests were approved by the Chief of Engineers in a letter to the Division Engineer, South Pacific Division, dated 2 August 1951, subject, "Authorization - Supplementary Skew Structures Program - Underground Explosion Tests".

3. Objectives. The objective of the Underground Explosion Test Programs is to secure experimental data for "developing - protective construction criteria and for designing and constructing protective military structures and underground installations". The immediate purpose of this supplementary program is to verify empirical scale relationships previously established from larger, equal and smaller scale tests on targets set with no skew, and to determine the movements and the visual damage to targets with faces set at varying skew angles and distances from the center-line of the charge. Control targets set with no skew were used in each round.

4. Cooperating Agencies. Office headquarters facilities at Dugway Proving Grounds were provided by the Chemical Corps, Department of the Army.

The Ordnance Department, Department of the Army, supplied explosives, and explosive storage facilities were made available at the Tooele Ordnance Depot.

The South Pacific Division Laboratory, Corps of Engineers, Department of the Army, performed the laboratory soil tests reported herein.

The Director, U. S. Coast and Geodetic Survey, Department of Commerce, furnished the services of a geodetic and precise level party to establish first order base lines and levels in the Dry Clay area, and to determine the vertical and horizontal position of fixed points on all target structures before and after the detonation of charges.

The Director, U. S. Geological Survey, Department of Interior, furnished the services of a geophysical survey party to extend preliminary seismic exploration of the area. The data have not been received for inclusion in this report.

Morrison-Knudsen Company, Inc., under contract to the Corps of Engineers, performed all construction work entailed by the program.

Pittsburgh Testing Laboratories, under contract to the Corps of Engineers, performed all concrete and steel testing required by the work.

Undisturbed soil samples have been forwarded to the Massachusetts Institute of Technology for eventual dynamically loaded triaxial shear tests.

5. Description of the Area. Dry Clay test site is located in Sections 2, 3, 10 & 11, T9S, R9W, S.L.B.&M., about 85 miles by road southwest of Salt Lake City, Utah. It is about 10 miles (airline) southeast of the present headquarters of Dugway Proving Grounds. The location is shown on Plate I.

The area consists of an even-surfaced valley lying between buried mountains, supporting limited, desert-type vegetation. The valley floor was formed by the deposition of sediments in ancient Lake Bonneville. The depth of these sediments is in excess of 160 feet. These undeformed beds are jointed into rectangular blocks by a major set of joints which are vertical and strike north-south, and a less prominent set of joints, also vertical, and about normal to the major set, which strike east-west. Seismic explorations indicate that velocities range from a minimum of 1,000 feet per second at a depth of 3.7 feet, to a maximum velocity of 6,150 feet per second at a depth of 93 feet. A typical boring log of the area is shown on Plate XII.

Clay is the chief material at the site with minor amounts of interbedded fine sand, silt and diatomaceous marl. The overburden is an unstratified mixture of silt and clay containing a small amount of humus. No water table was encountered at any exploratory drill hole in the area. The joint systems allow the limited annual rainfall to penetrate deeply and the underlying material is slightly damp at all times. A detailed geologic study of the site is included in Reference 3.

6. Laboratory Soil Tests. Two undisturbed soil samples were obtained at a preliminary test site at a depth of 4.5 to 5.4 feet below the ground surface. The location of the site is shown on Plate II. One sample could not be used for testing owing to its highly fractured condition, and only a limited number of specimens could be secured from the second sample, obtained prior to detonation.

The results of classification tests, using standard procedures, are given below:

Div. Serial No.	Laboratory Classification	Mechanical Analysis % Finer No. 60	No. 270	5 Mic.	Liquid Limit	Plasticity Index
278-SA	Silty Clay	100	99	42	43	14
279-SA	Silty Clay	100	99	33	45	16

The specific gravity of similar material from the area is 2.79.

Specimens from Sample No. 278-SA, with a diameter of 1.4 inches and a height of 3.25 inches, were tested to determine the shear strength at natural moisture content, using both triaxial and unconfined compression tests, and the effect of varying lateral pressures upon the shear strength, using triaxial tests. Density determinations were obtained from weights and physical dimensions of test specimens. The test results are shown in Figure 1.

The Division Laboratory states:

> "The Modulus of Deformation may be defined as the average deviator stress per unit strain between the origin and a point on the stress-strain curve at one-third of the maximum deviator stress. The data indicate that the modulus of deformation increases with an increase in lateral pressure from overburden,

which is approximately 0.2 Kg per cm^2 to 2 Kg per cm^2 but decreases when the lateral pressure is raised to 4 Kg per cm^2. While this behavior is not consistent with average results obtained from other test sites in the area, these differences could be attributed in part to variations in the nature of the soil and the initial density of the specimens. The curved line forming the Mohr envelope is believed to represent, more nearly, the true values for this material. The straight dashed line represents an average shear strength for all four specimens.

"The difference in value for the modulus of deformation as obtained by unconfined compression tests compared to triaxial tests, may be explained by small variations within the specimens as well as by the different types of apparatus."

Additional test results on soil samples from the Clay test area are given in References 1, 2, 3, 4 and 5.

7. Target Fabrication. The target structures were pre-cast in Salt Lake City. The concrete mix was designed for a strength of 4,000 p.s.i. at 28 days using Type I Portland Cement (Federal Specification No. SS-C-192). High early strength cement was substituted for the Type I in order to adhere to the program schedule. The concrete proportions by dry weight were: cement - 1; sand - 2.09; and aggregate - 3.13. The maximum size of coarse aggregate used in the mix was 1/2 inch. The designed cement factor was 6.2 sacks per cubic yard, the slump 5 inches, and the water-cement ratio, 0.915. The concrete was vibrated into place in the forms taking care not to disturb the designed steel spacing. Steel reinforcement "ears" were set in the corners of each target to facilitate handling. The targets were covered with heavy burlap maintained in a saturated condition and cured at the fabrication site for 3 days. The targets were then transported by truck to the test site and stored in the open until used. Plate III illustrates the target details.

Concrete was sampled in accordance with A.S.T.M. standards. Two test cylinders, 3 x 6 inches, were fabricated from concrete for each target. The cylinders were cured in the same manner as the targets, and stored in the open to duplicate the conditions of target storage. One cylinder from each target was broken as closely as practicable at 7 days of age, and the second cylinder as closely as practicable on the day the charge for the respective target was detonated. The results of the concrete compression tests are scheduled in Figure 2.

One reinforced concrete test beam, 6 x 13-1/2 x 57 inches, using steel reinforcement identical to that placed in the target structures, was fabricated with concrete sampled from Target T-6. The beam was cured and stored in a manner similar to that of the target, and tested as a simple beam under a third point loading condition as closely as practicable on the day Round S-3 was detonated. Details of the test beam and the location of points of cracking are shown in Figure 3. The test data is scheduled in Figure 4 and plotted in Figure 5.

Steel reinforcement for the targets consisted of new type, deformed bars specified to conform to the following requirements:

a. Yield point not to exceed 65,000 p.s.i.

b. Ultimate strength not to exceed 100,000 p.s.i.

c. Variance from the average yield point of the samples tested not to exceed 10 - 12 percent.

d. All samples to have similar stress-strain diagrams.

A summary of tension tests on reinforcement bars sampled from the material used in the targets is scheduled in Figure 6. Stress-strain diagrams of steel reinforcement samples conforming to the same specifications and used in earlier targets of the program are contained in Reference 4.

8. Charge. Each charge consisted of 2,560 pounds of rectangular, precision-cast TNT blocks stacked to approximate a sphere. The center of gravity of each charge was set 7 feet below the ground surface. Some of the 100 pound blocks were cast with priming slots. M-1 demolition chain blocks containing primacord and tetratol were used in the slots permitting thorough priming of the stack without disturbing the intimate contact of adjacent blocks. Two primacord leads were brought to the surface in steel conduits. The leads were detonated with electrical caps and a hand-operated blasting apparatus. A detail of the charges is shown on Plate IV.

9. Target Preparation. No construction work had occurred in the immediate area prior to the preparations for Rounds S-2 and S-3. Two preliminary detonations, about 400 feet west of the immediate test area, one at 0.1 scale and one at 0.2 scale, which resulted in no damage to the targets used, were made to establish the test distances from charge to targets for Round S-2. Test distances for Round S-3 were determined from the results of Round S-2. Target layouts for Rounds S-2 and S-3 are shown on Plates IV and XII.

General information on the test rounds is tabulated below:

Target	Type	Radius Feet	Radius Scale λ	Skew Angle Degrees
		Round S-2		
R-5	Open box	33	2.42	45
R-3	" "	29	2.12	45
R-2	" "	25	1.83	45
R-1	" "	29	2.12	Zero
T-3	Hollow Cube	20	1.46	45
T-2	" "	20	1.46	30
T-1	" "	20	1.46	Zero
		Round S-3		
R-4	Open box	23.96	1.75	Zero
R-7	" "	24.08	1.76	30
R-6	" "	25.00	1.83	Zero
T-7	Hollow Cube	17.46	1.28	45
T-6	" "	17.58	1.29	30
T-5	" "	18.50	1.35	Zero

Note: Radius = Distance from center-line of charge to closest point on the target

Radius Scale: λ = Radius X (Weight of Charge)$^{-\frac{1}{3}}$

The targets were lowered by a crane and jacked into place. Alignment, distance and grade of each target were carefully checked. Referenced medium movement stakes were buried adjacent to the targets close to the top of the ground.

The targets were backfilled in 6 to 8 inch layers, with moistened material obtained from the required excavation, and tamped with pneumatic hand tampers. Care was exercised in applying water and in tamping the material in order to place the backfill, as closely as practicable, to the same density as that of the undisturbed medium. Soil tests of field samples, however, indicate that some variation in density and moisture content did occur, and that the properties of the original medium, due to its unique structural characteristics, were altered by the excavation and backfilling operations. A summary of tests on samples taken to determine moisture content and density, as determined by the sand-displacement method, is scheduled in Figure 22.

10. Data. The true and apparent craters caused by the detonations are shown on Plates IV and XII. The true craters were determined by probing with a steel rod, since a previous comparison of the results obtained using a hollow-tube type sampler and a steel probe not only indicated excellent correlation but resulted in a considerable savings in the cost of the field work for this operation.

The motions of the medium movement stakes placed adjacent to the targets prior to the detonation are shown on Plates IV and XII.

The results of visual examination of the targets are shown on Plates V to XI and XIII to XVIII. The locations of cracks and offsets on cracks are plotted to scale and the crack sizes are specified. While the crack locations are shown accurately, in only a few instances were the cracks in the targets as straight as those shown on the drawings. The drawings should be interpreted as showing the location of the probable center-line of a crack between points of major changes of direction. The

sizes of the cracks were measured accurately to the limits specified on the drawings. Primary emphasis was given to determining the relative size of the cracks in a crack system or a face rather than in determining crack sizes to a more detailed degree than that specified.

Tension cracks, generally, were open and well defined. Compression cracks were closed, but by comparison with tension cracks had distinctly different characteristics. A faint hair-line crack could be determined only by tracing the course of the crack by means of selective absorption. A compression "zone" consists of a comparatively wide area that had been subjected to stress, the outer fibers of which had been crushed. A shear "zone" consists of a series of parallel cracks of different sizes, usually associated with numerous small spalls.

Offsets on a crack were measured as accurately as possible by means of a straight-edge and scale.

The profiles of target faces were determined by measuring offsets to the target at the designated point from a template with a constant gage distance. In all instances the measurements were made after the detonations and the profiles must be interpreted as reflecting both initial (minor) wall deflections from an ideal plane due to construction, and those due to deformation as a result of the detonation.

Movements of fixed points on the targets, determined by the U. S. Coast and Geodetic Survey, are shown in Figures 7 to 19. The component movements of the points relative to the center-line of the charge are scheduled in Figure 20 for Round S-2 and Figure 21 for Round S-3.

Photographs 3 to 15 show the faces of the targets damaged by the detonations.

REFERENCES

1 - Preliminary Soils Exploration
Underground Explosion Test Program
Dugway Proving Grounds, Utah
Sacramento District, Corps of Engineers
April 1948

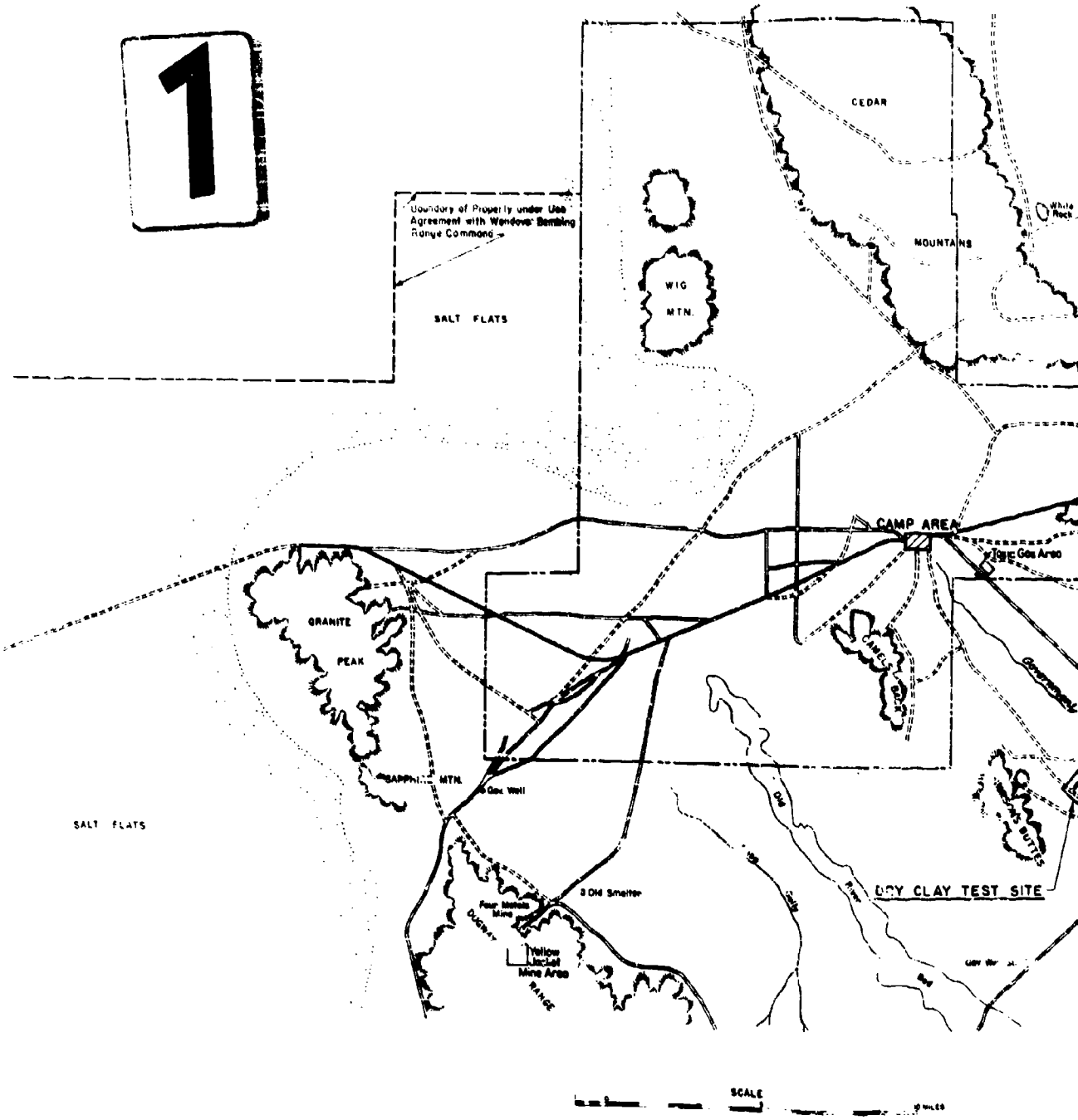
2 - Report of Soil Tests
Underground Explosion Tests, Dry Clay
South Pacific Division Testing Laboratory
Corps of Engineers
17 September 1948

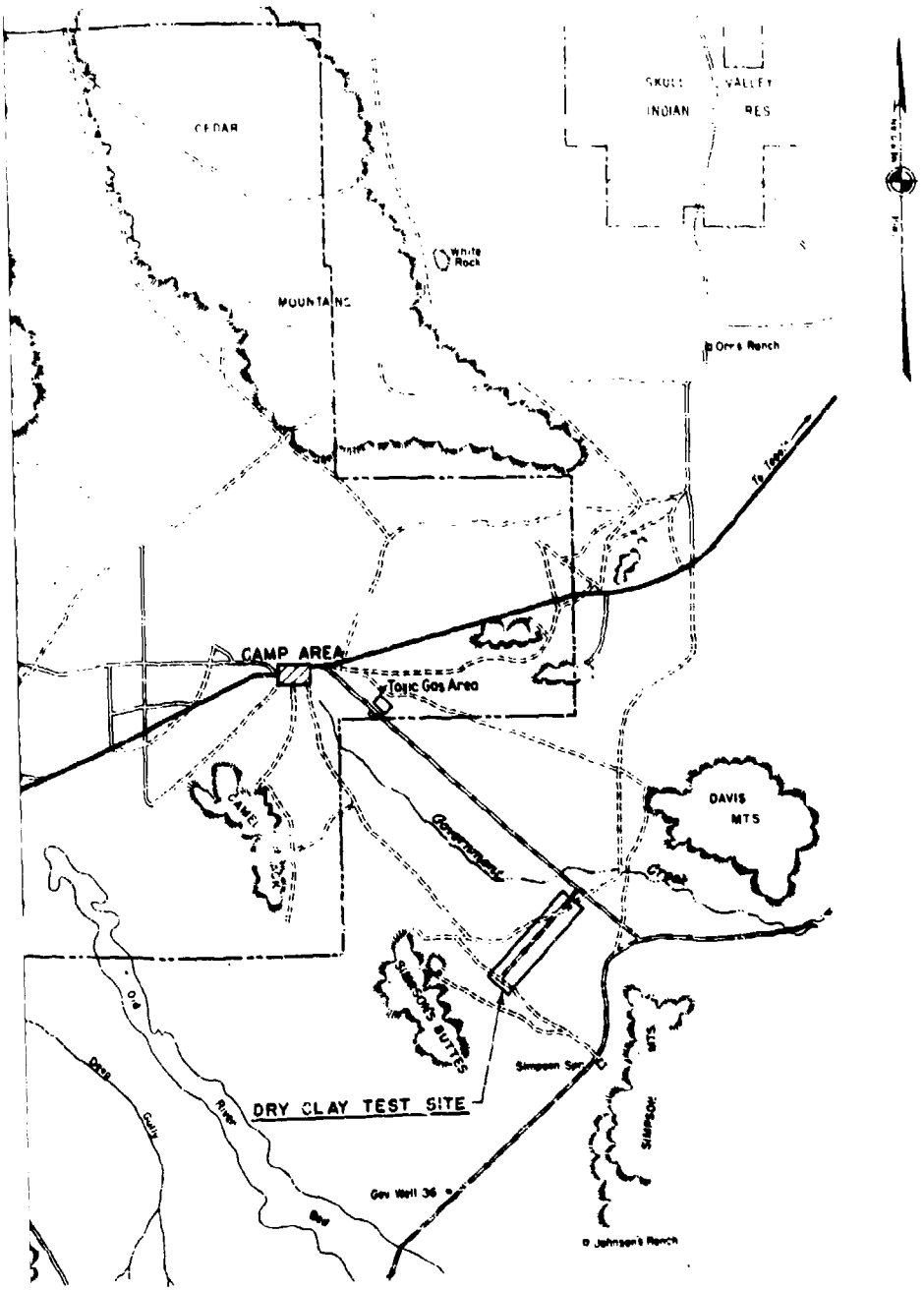
3 - Underground Explosion Tests
Volume III - Dry Clay
Appendix A - Geology
Corps of Engineers, U. S. Army
Office, District Engineer, Sacramento, California
May 1949

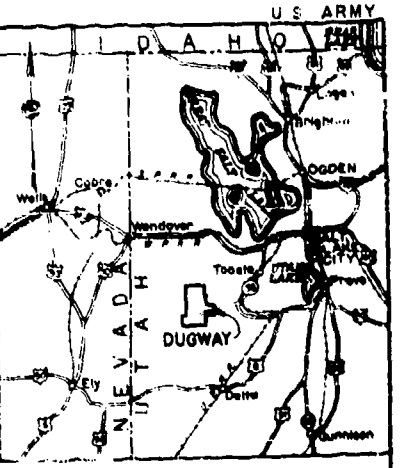
4 - Underground Explosion Tests
Volume III - Dry Clay
Appendix B - Construction
Corps of Engineers, U. S. Army
Office, District Engineer, Sacramento, California
June 1949

5 - Report of Soil Tests
Underground Explosion Tests Program
Dry Clay Site
South Pacific Division Laboratory, Sausalito, Calif.
October 1951

1


CEDAR
MOUNTAINS
White Rock
Boundary of Property under Use Agreement with Wendover Bombing Range Command
SALT FLATS
WIG MTN.
CAMP AREA
Test Gas Area
GRANITE PEAK
SAPPHIRE MTN.
Gas Well
SALT FLATS
Old Smelter
Four Metals Mine
Yellow Jacket Mine Area
DRY CLAY TEST SITE
SCALE





VICINITY MAP

2

EXPLANATION

- Dugway Proving Grounds Boundary Line
- Surfaced Roads
- Graveled Roads
- Unimproved Roads
- Wagon Trails

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
SACRAMENTO DISTRICT
SACRAMENTO, CALIFORNIA

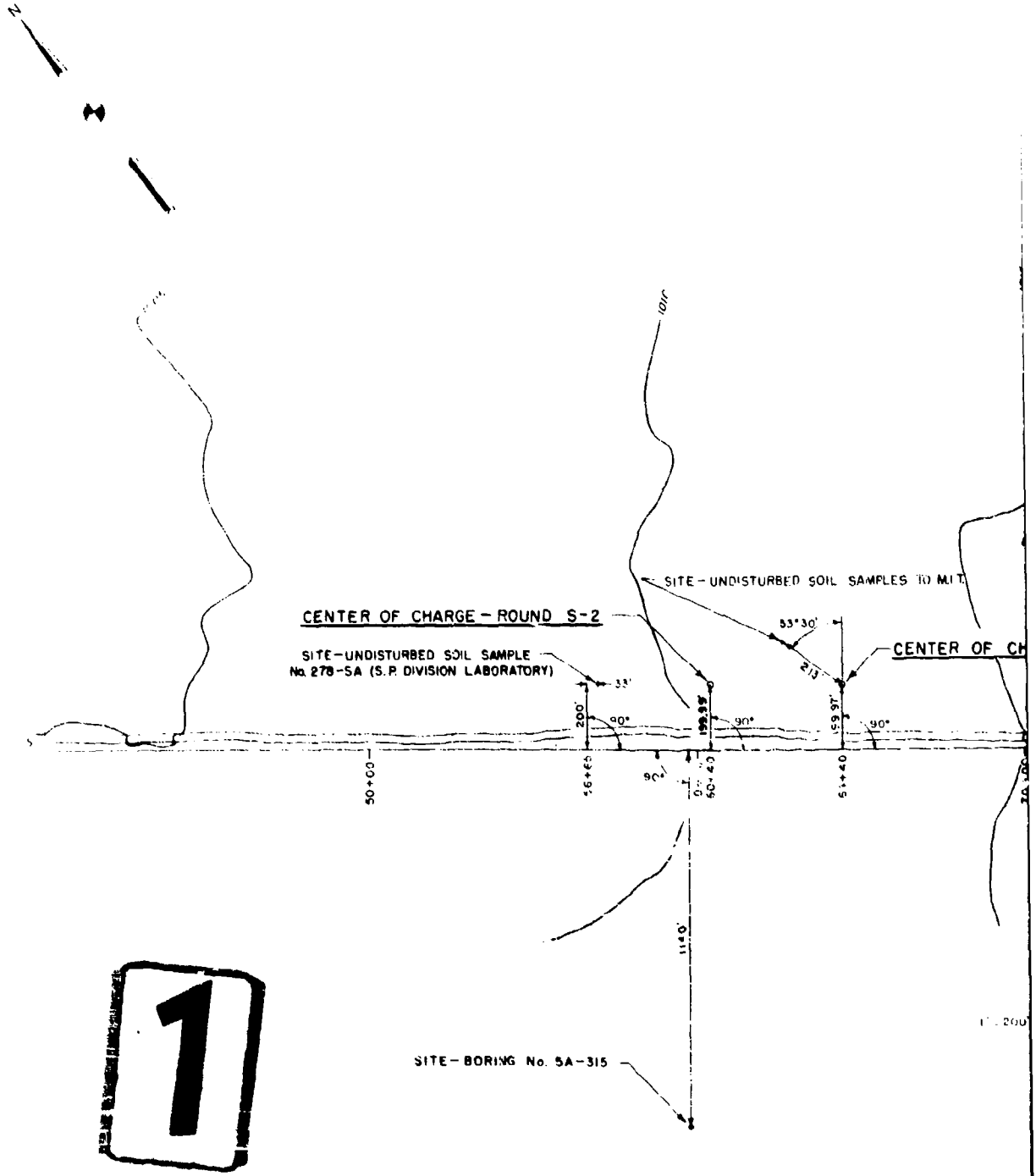
UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM
TEST SITE LOCATION

DATE: 21 FEB 1952

84-01-162

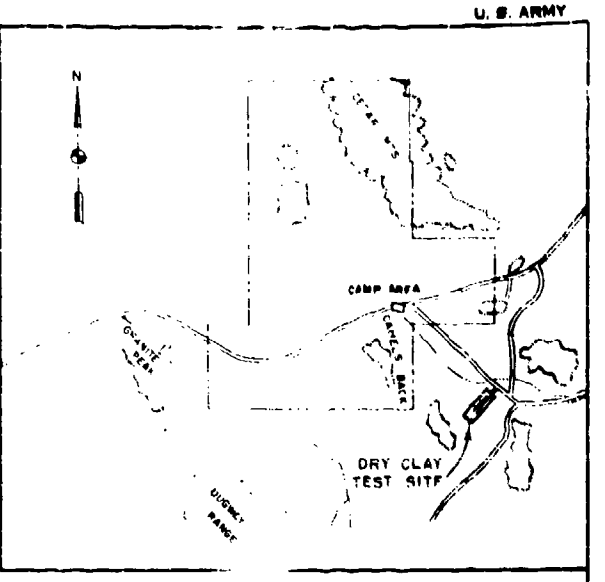
CONFIDENTIAL - SECURITY INFORMATION

PLATE 1


N
SITE - UNDISTURBED SOIL SAMPLES TO M.I.T.
CENTER OF CHARGE - ROUND S-2
SITE - UNDISTURBED SOIL SAMPLE
No. 278-SA (S.P. DIVISION LABORATORY)
CENTER OF CH
53°30'
213'
33'
200'
90°
159.97'
50+00
56+65
60+40
61+40
1140'
SITE - BORING No. SA-315

1

U. S. ARMY



LOCALITY MAP

0 5 10 15 MILES

SITE UNDISTURBED SOIL SAMPLES TO MIT

CENTER OF CHARGE — ROUND S-3

Road

Base Line

1020

1025

90°

90°

53°30'

213

1565

1565

1140

00+00

00+36

00+63

00+63

14+40

70+00

80+00

2

GRAPHIC SCALE

1" = 200' 0 100' 200' 400' 600' 800' 1000'

DESIGNED	H.E.R.
DRAWN	A.L.
CHECKED	H.E.R.
SUBMITTED BY	

COPIES OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
SACRAMENTO DISTRICT
SACRAMENTO, CALIFORNIA

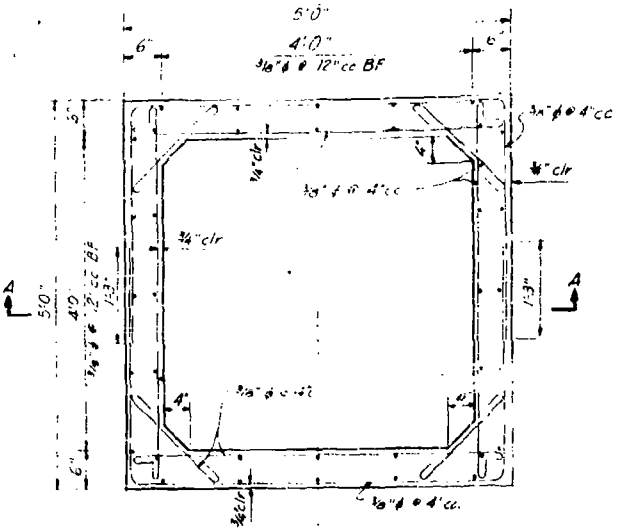
UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SNOW STRUCTURES PROGRAM

CHARGE LOCATIONS

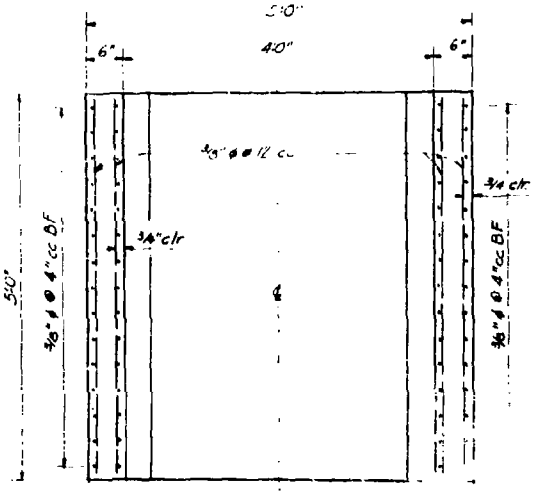
APPROVED: H. C. Vanderpool, Acting District Engineer
DATE: 21 FEB 1952

SCALE: AS SHOWN
SHEET 2 OF 19 SHEETS
FILE NO. 34-01-162

CONFIDENTIAL - SECURITY INFORMATION PLATE II



PLAN

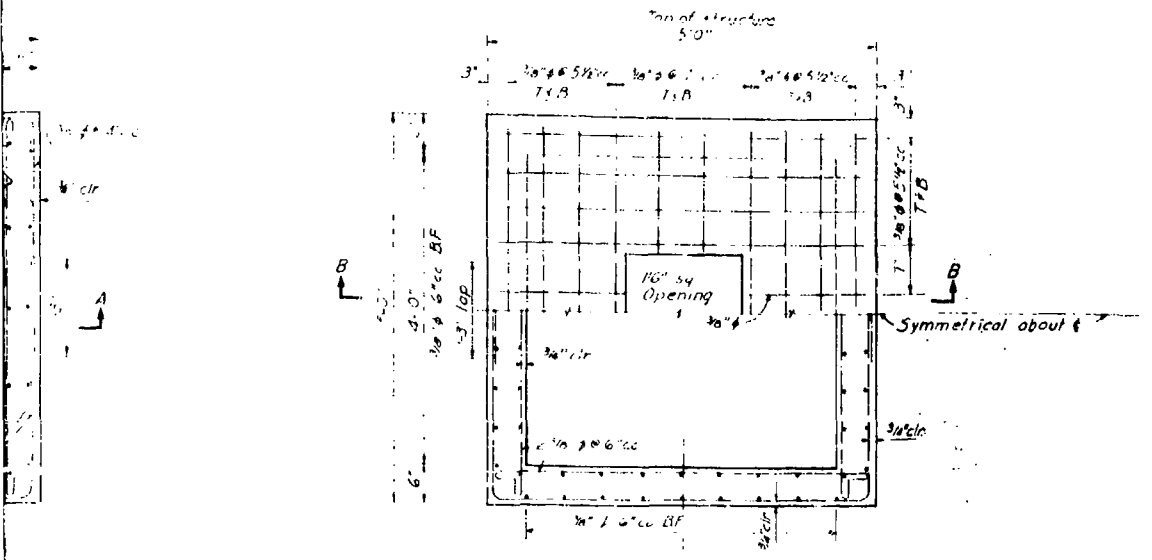


SECTION A-A

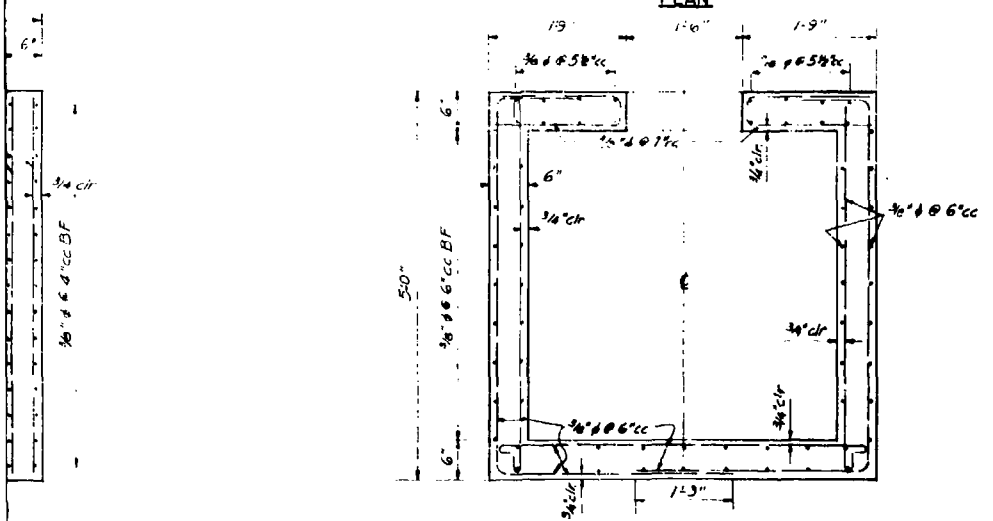
TARGET TYPE "R"

SCALE : 1"=1'0"





PLAN



SECTION AB

TARGET TYPE "T"

SCALE: 1"=1'0"

GRAPHIC SCALE

1"=1'0" 0" 1' 2' 3'

2

COPIES OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
SACRAMENTO DISTRICT
SACRAMENTO, CALIFORNIA

UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM

TARGETS
PLANS AND SECTIONS

DESIGNED H.E.R.
DRAWN
TRACED
CHECKED
APPROVED
DATE 21 FEB 1952

SCALE AS SHOWN
SHEET 5
DRAWING NO. 84-01-162

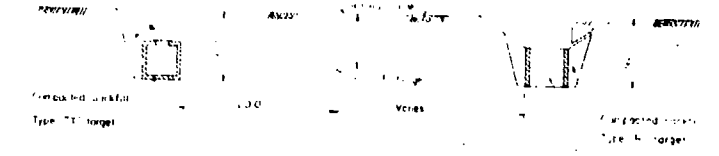
CONFIDENTIAL - SECURITY INFORMATION

PLATE III

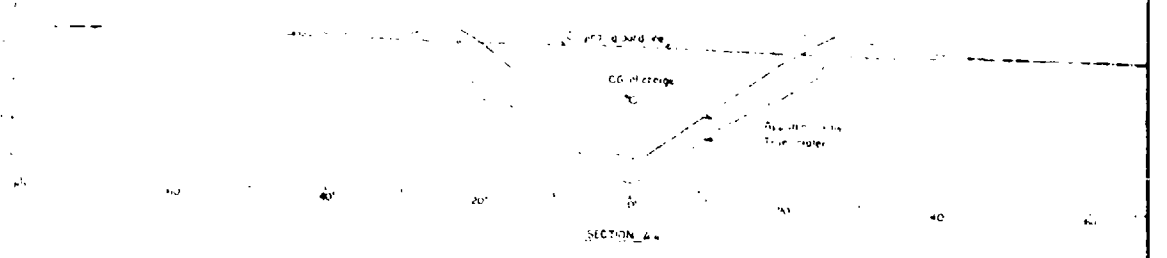


PLAN

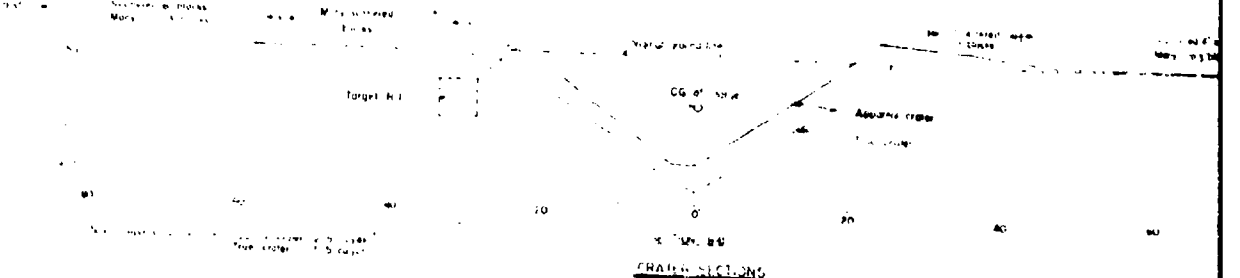




TYPICAL ORIGINAL SECTION



SECTION A-A



CRATER SECTIONS

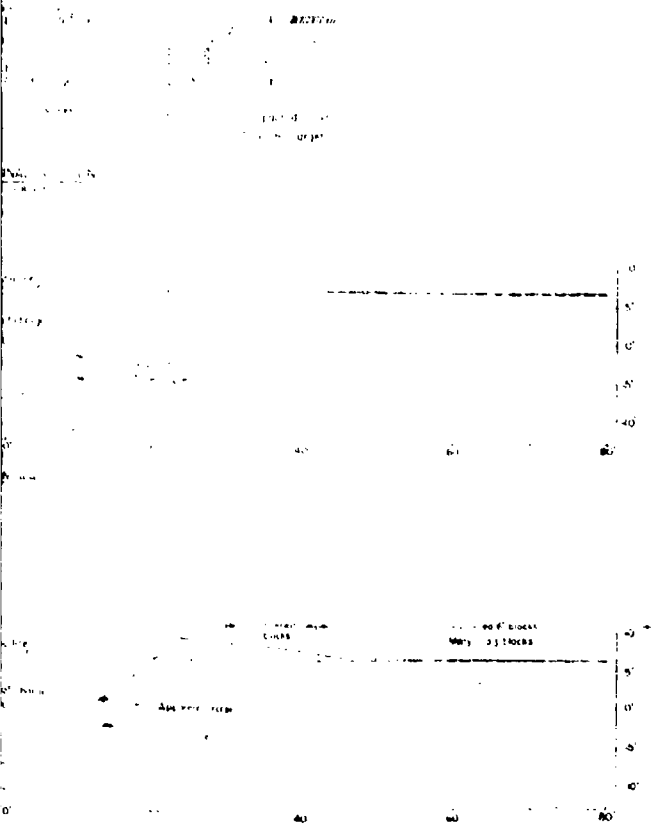
U. S. ARMY

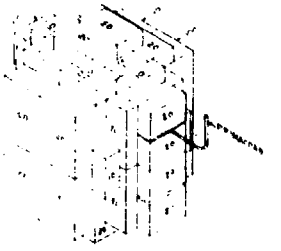


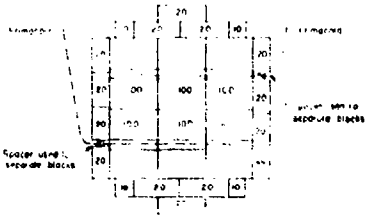
NOTE
Motion Stakes
NF Stake not to be located after detonation
Target movements are scheduled in Figure 20

MOTIONS: MEDIUM MOVEMENT TANK

SCALE PLAN VIEW
1:50







SECTION THRU X OF CHARGE

20-40 Pound blocks
24-20 Pound blocks
8-10 Pound blocks
Total 2960 Pounds

Note: Overall approximate dimensions of charge 4'-0" long, 3'-8" wide and 4'-1" high.

LEGEND
NO SCALE

GRAPHIC SCALE

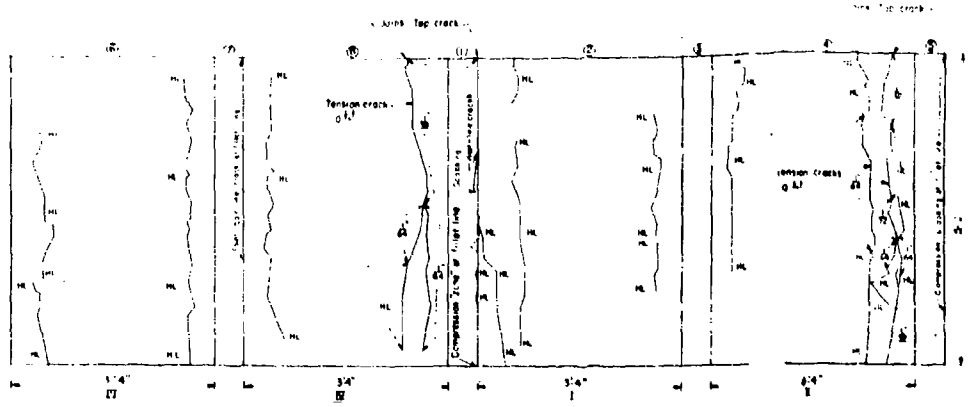
GENERAL NOTES

1. Target faces are designated I, II, III, IV clockwise
2. Rivets are numbered clockwise and designated #

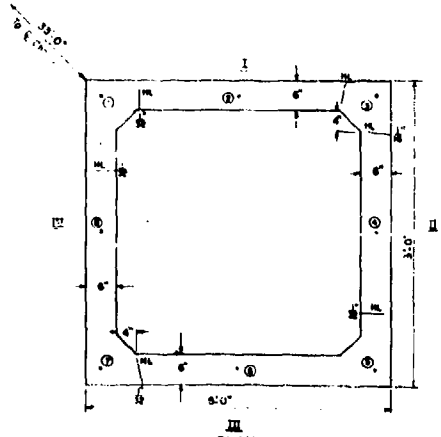
DESIGNED	H.E.H.	UNDERGROUND EXPLOSION TESTS
DRAWN		SUPPLEMENTARY SKEW STRUCTURES PROGRAM
CHECKED	H.E.H.	ROUND S-2
SUBMITTED	Lt. Col. A.J. Pomerene	PLANS AND SECTIONS
		AS SHOWN
		DRAWING NO. R4-01-162

CONFIDENTIAL SECURITY INFORMATION

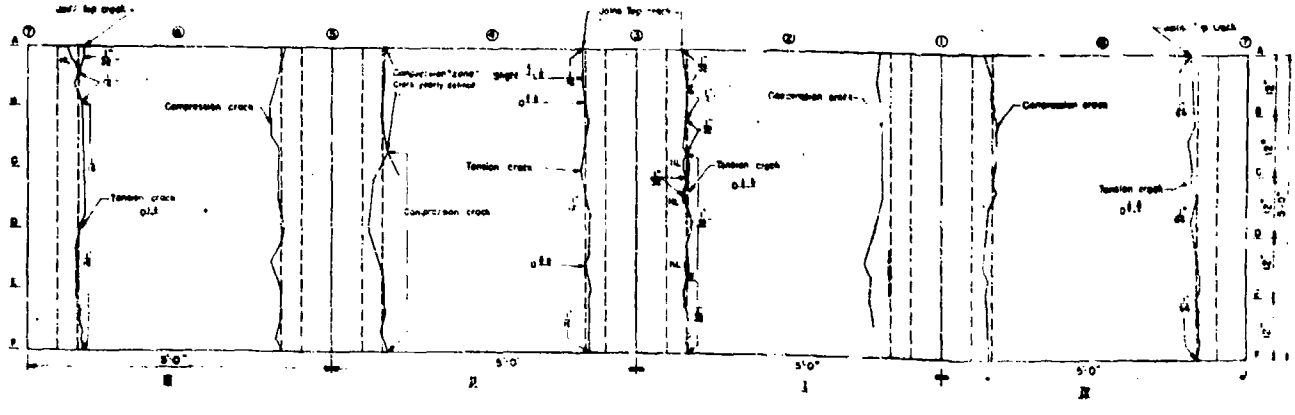
PLATE IV



DEVELOPED ELEVATION - INTERIOR WALLS



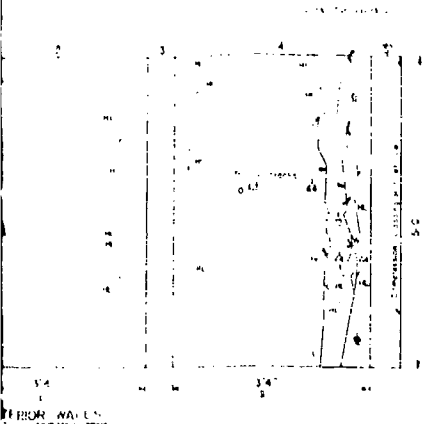
PLAN

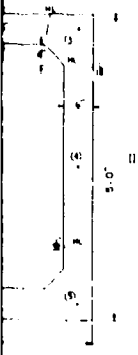


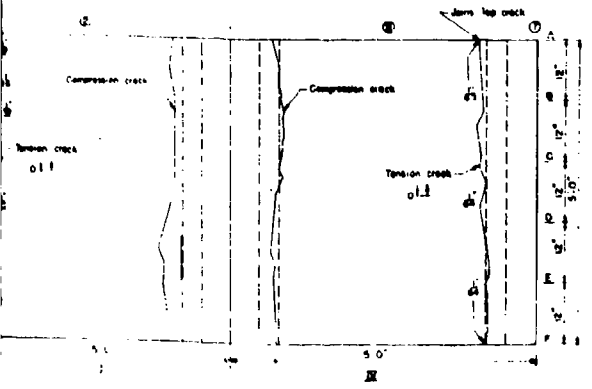
DEVELOPED ELEVATION - EXTERIOR WALLS

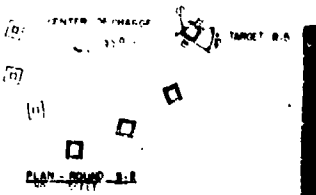
U. S. ARMY

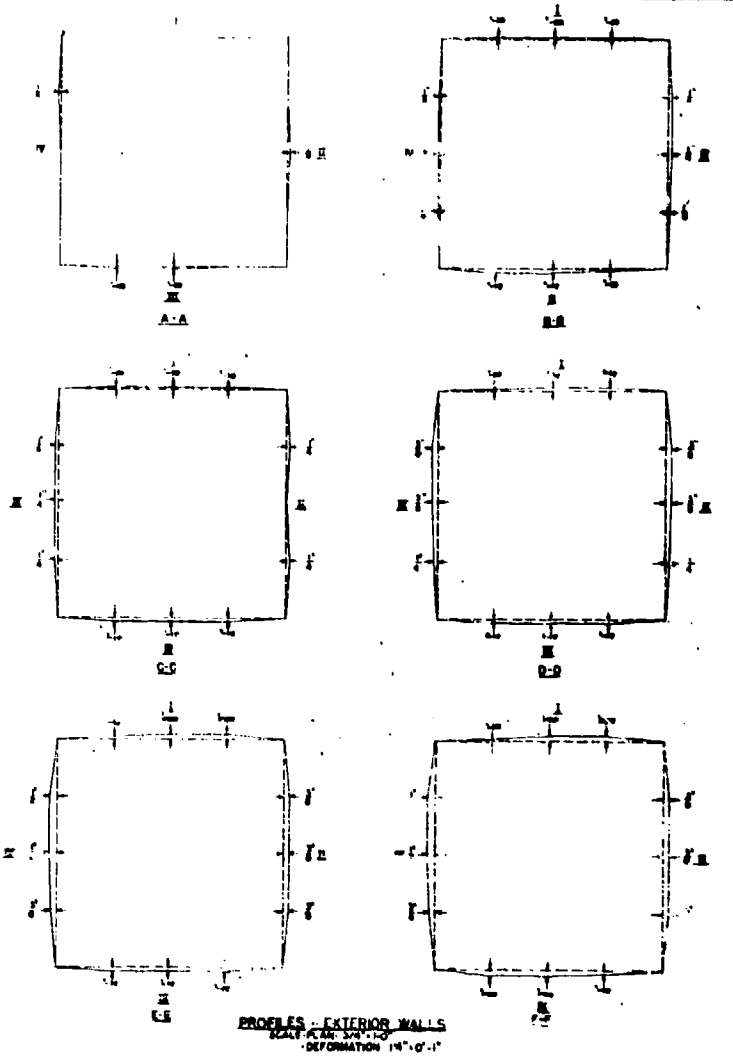
2











PROFILES - EXTERIOR WALLS
SCALE: PLAN 3/4"=1'-0"
DEFORMATION 1/4"=1'-0"

GRAPHIC SCALES

1"=1'-0"
1/2"=1'-0"
1/4"=1'-0"

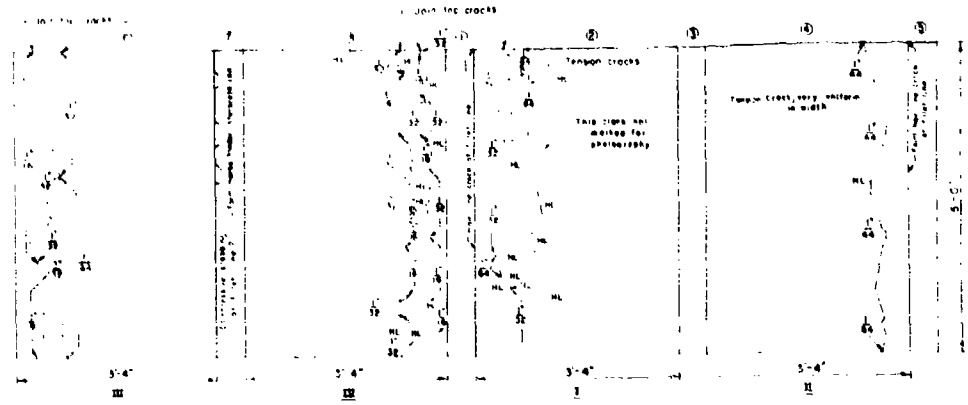
GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise
2. Rivets are numbered clockwise and designated C
3. Cracks and offsets of cracks are labeled to scale
4. Hairline cracks (~1/16") are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when zero blanks are not indicated
6. Crack offset symbols are shown in section

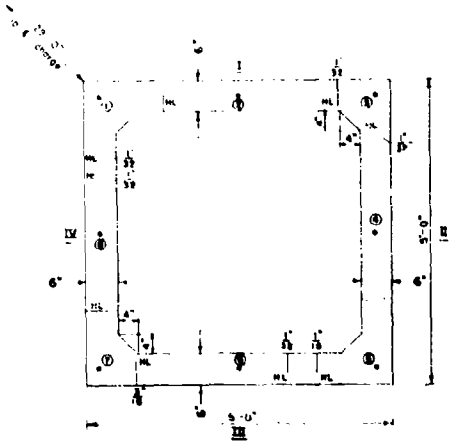
HEP	UNDERGROUND EXPLOSION TESTS
	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
	ROUND 5-2
	TARGET R-5
	CRACK PATTERNS & WALL DEFORMATION
	AS SHOWN
	84-01-162

CONFIDENTIAL - SECURITY INFORMATION

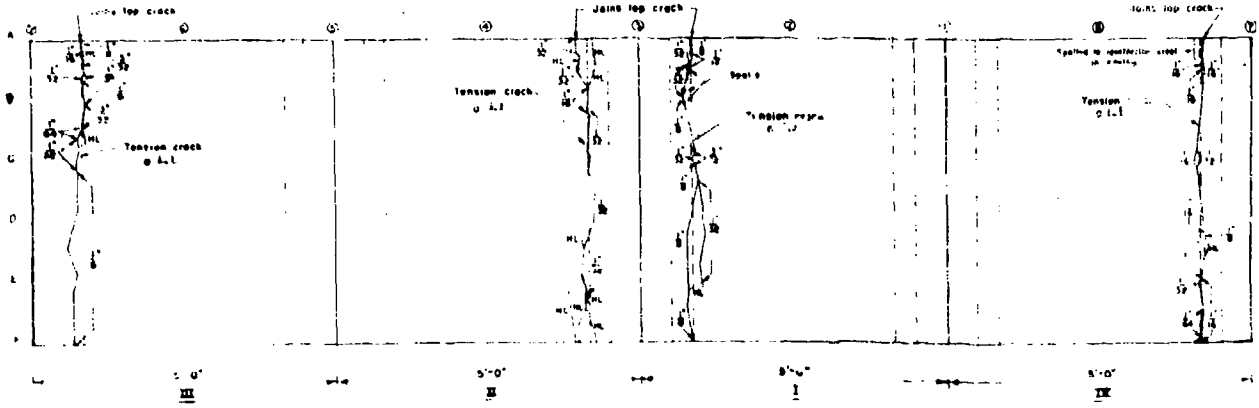
PLATE V



DEVELOPED ELEVATION — INTERIOR WALLS



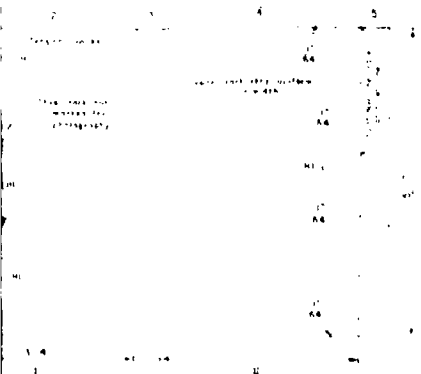
PLAN



DEVELOPED ELEVATION — EXTERIOR WALLS

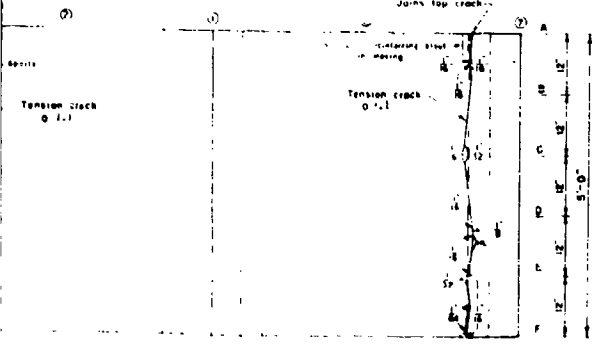
U. S. ARMY

2

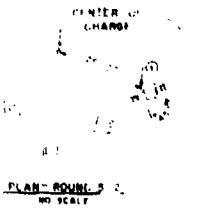


ERIOR WALLS

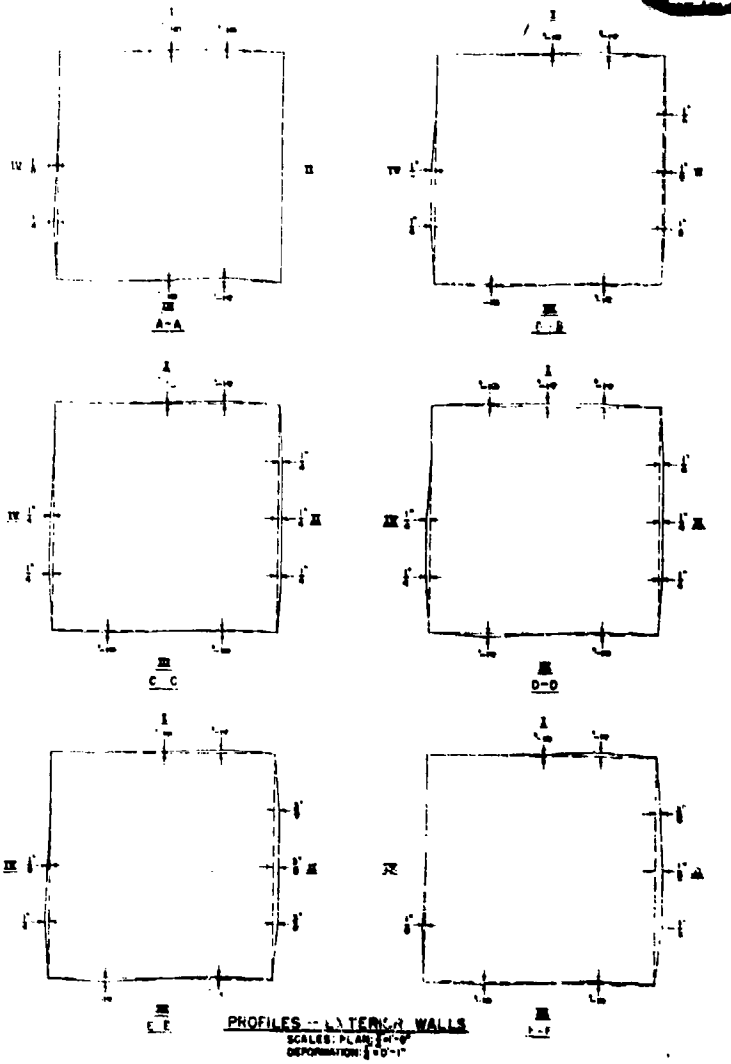




IOR WALLS



PLAN - ROUND S-2
NO SCALE



PROFILES -- INTERIOR WALLS
SCALES: PLAN 1/4"=1'-0"
DEFORMATION 1/4"=1'-0"

GRAPHIC SCALES

1"=1'-0"
3/4"=1'-0"
1/2"=1'-0"

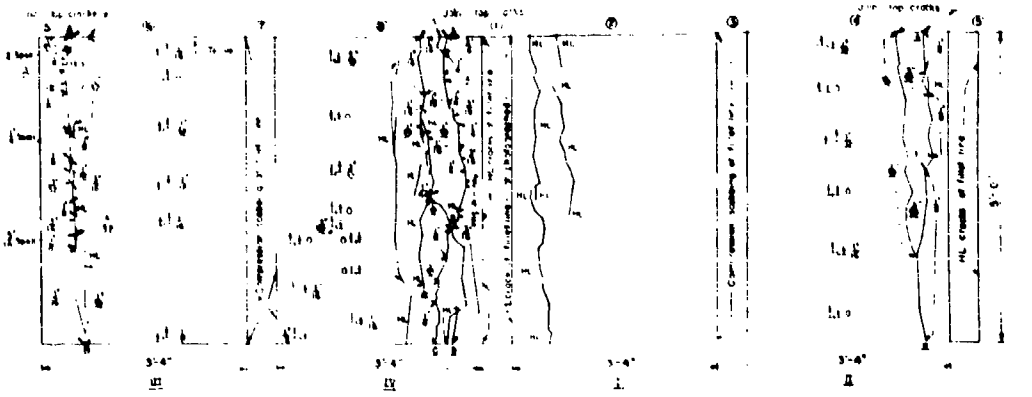
GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise
2. Rivets are numbered clockwise and designated ○
3. Cracks and offsets of cracks are located to scale
4. Hairline cracks (- - -) are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated
6. Crack offset [illegible] as shown in section
7. No specific compression crack or zone was observed

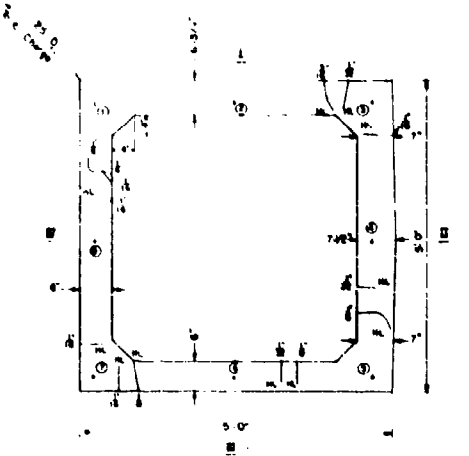
H.F.R.	UNDERGROUND EXPLOSION TESTS
	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
H.L.R.	ROUND S-2
	TARGET R-2
	CRACK PATTERNS & WALL DEFORMATION
	WES No. P4-01-162

CONFIDENTIAL - SECURITY INFORMATION

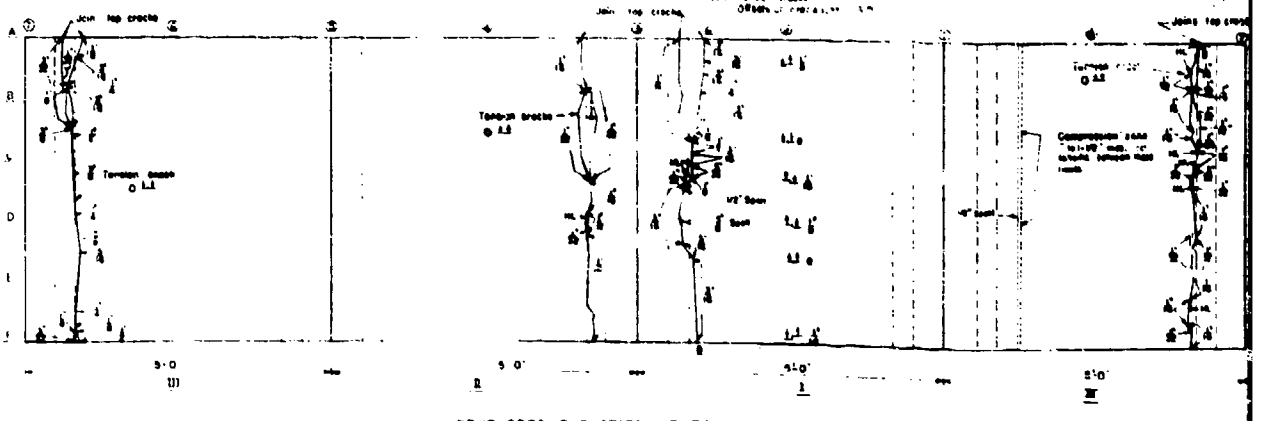
PLATE VI



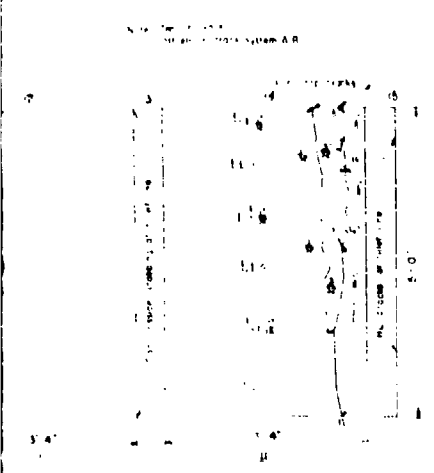
DEVELOPED ELEVATION — INTERIOR WALLS



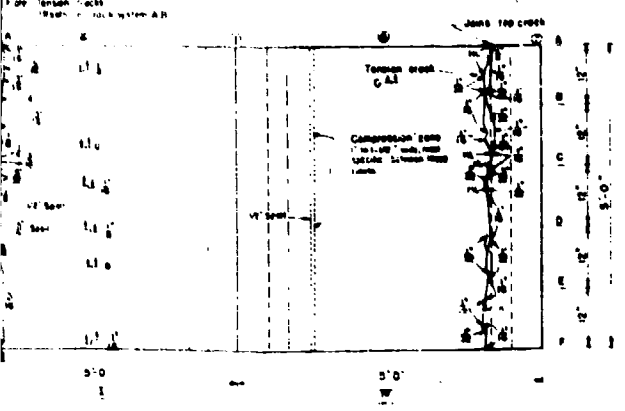
PLAN

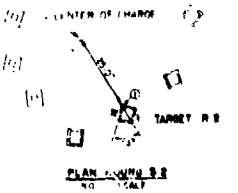


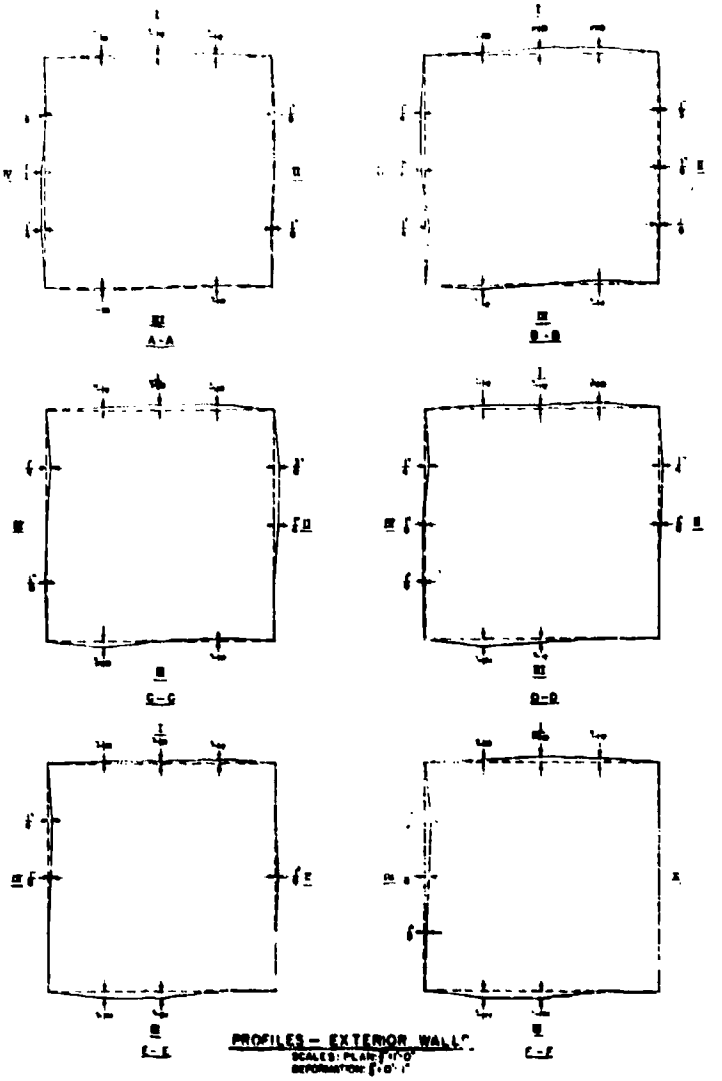
DEVELOPED ELEVATION — EXTERIOR WALLS











PROFILES – EXTERIOR WALLS

SCALES: PLAN 1"=5'-0"
DEFORMATION 1"=0'-1"

GRADE SCALES

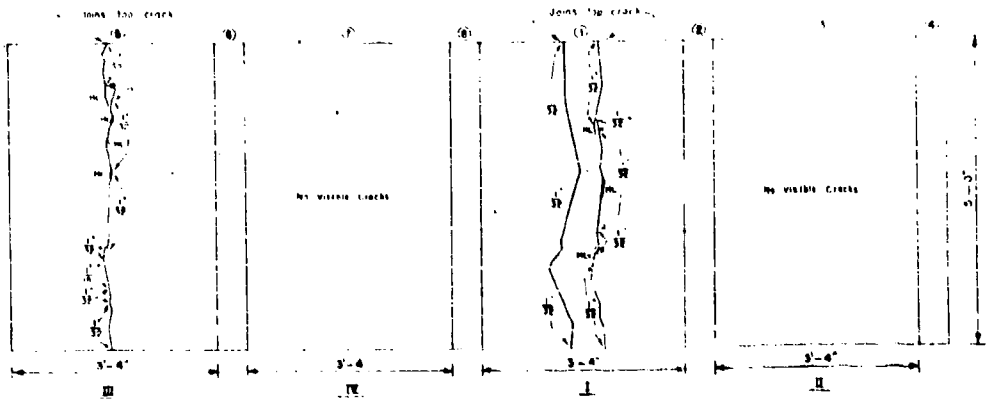
GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise.
2. Cracks are numbered clockwise and designated ⓒ.
3. Cracks and offsets of cracks are located to scale.
4. Hairline cracks (-Δ-) are specified "HL".
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated.
6. Crack offset symbols are shown [illegible]

DES	UNDERGROUND EXPLOSION TESTS
DR	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
	ROUND 5-2
	TARGET R-2
	CRACK PATTERNS & WALL DEFORMATION
	Scale AS SHOWN
	DNA 84 01-162

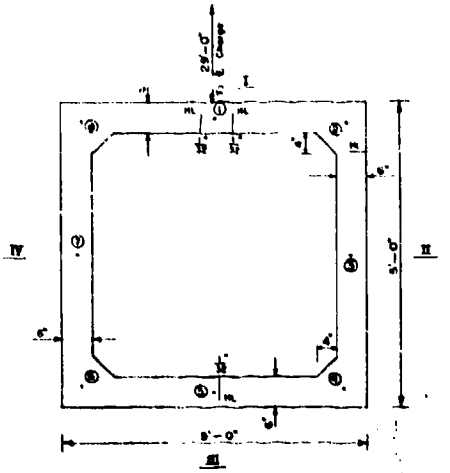
CONFIDENTIAL SECURITY INFORMATION

PLATE 21



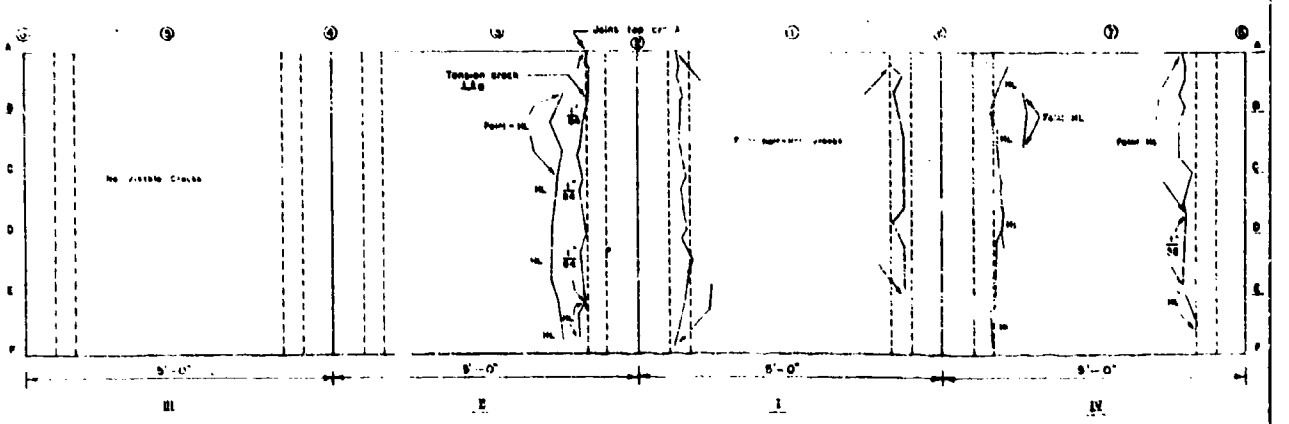
DEVELOPED ELEVATION – INTERIOR WALLS

SCALE 1" = 1'-0"



PLAN

SCALE 1" = 1'-0"

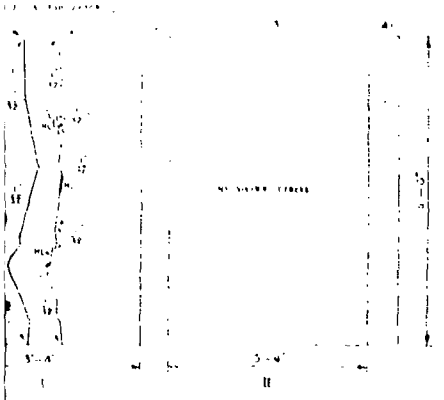


DEVELOPED ELEVATION – EXTERIOR WALLS

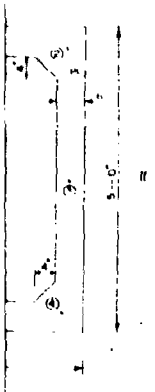
SCALE 1" = 1'-0"

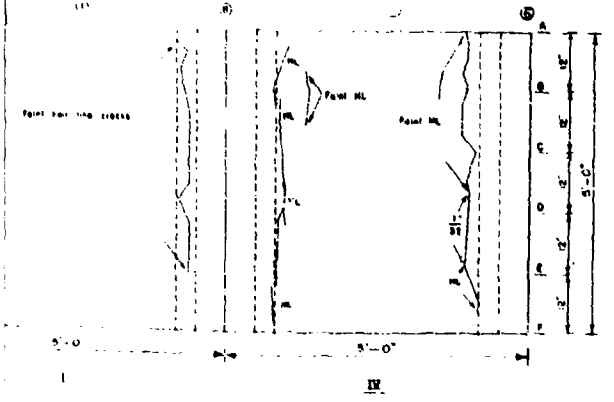
U. S. ARMY

2

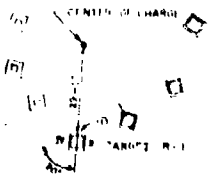


INTERIOR WALLS

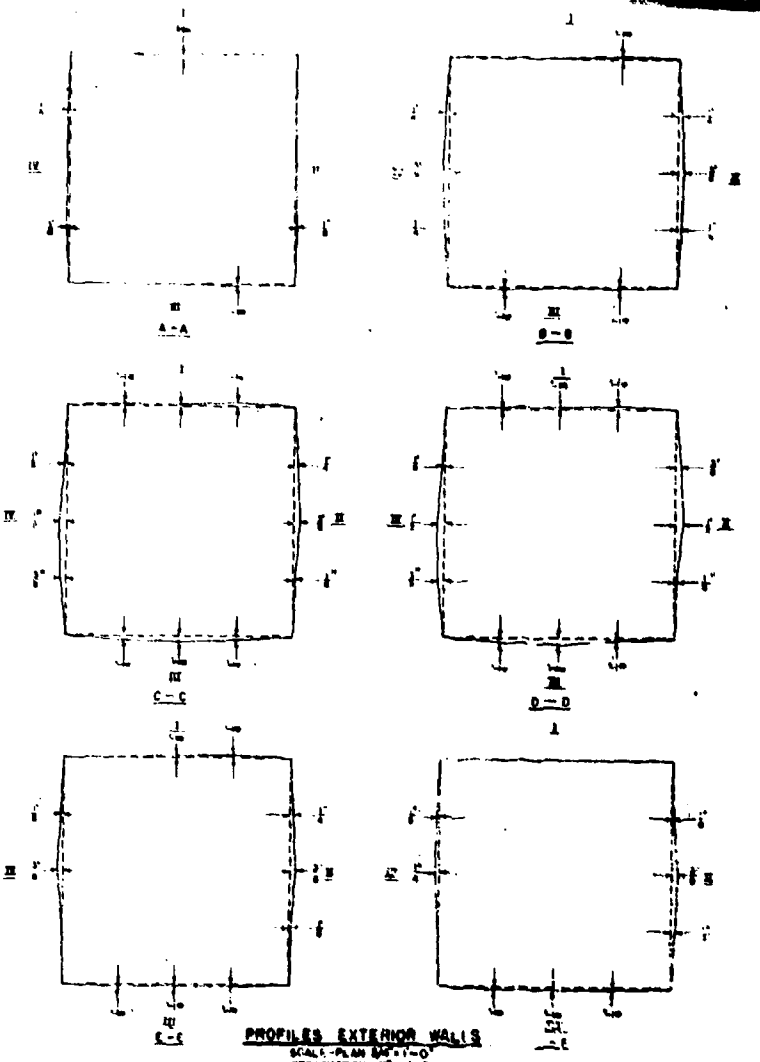




EXTERIOR WALLS



PLAN — ROUND 1-2



PROFILES EXTERIOR WALLS

GRAPHIC SCALES

GENERAL NOTES

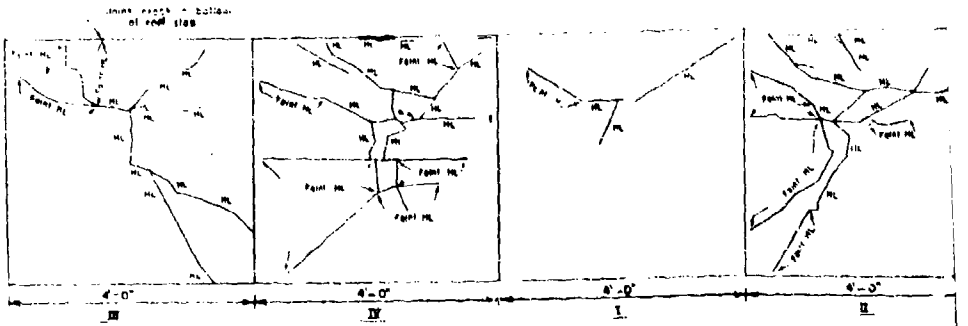
1 — Target faces are designated I, II, III, or IV clockwise.
2 — Rivets are numbered clockwise and designated (x).
3 — Cracks and offsets at cracks are located to scale.
4 — Hairline cracks (1/64") are specified "HL".
5 — Crack sizes vary uniformly between the dimensioning specified where end limits are not indicated.
6 — Crack offset symbol are shown in section
7 — No specific compression crack or spall was observed

H.L.R.	UNDERWATER EXPLOSION TESTS SUPPLEMENTARY BLOW STRUCTURES PROGRAM	
M.A.	ROUND 1-2	
H.L.R.	TARGET R-1	
	CRACK PATTERNS & WALL DEFORMATION	
		2' 84-01-1617

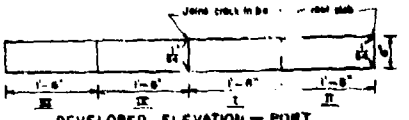
CONFIDENTIAL - SECURITY INFORMATION

PLATE VIII

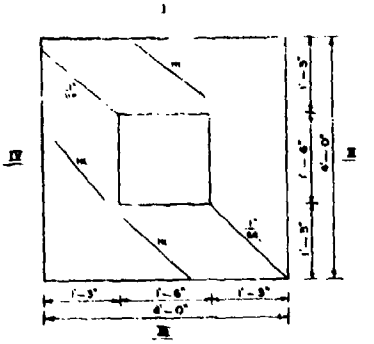
1



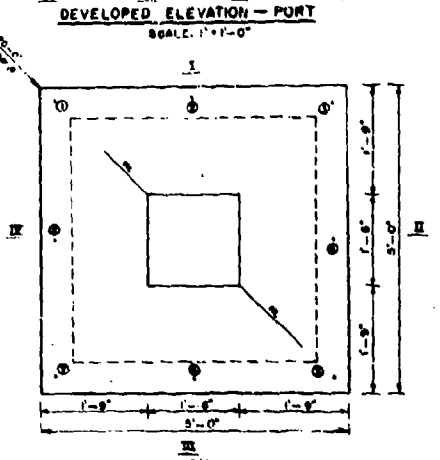
DEVELOPED ELEVATION — [illegible] OF WALLS
SCALE: 1" = 1'-0"



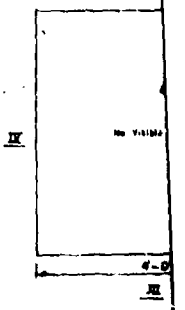
DEVELOPED ELEVATION — PORT
SCALE: 1" = 1'-0"



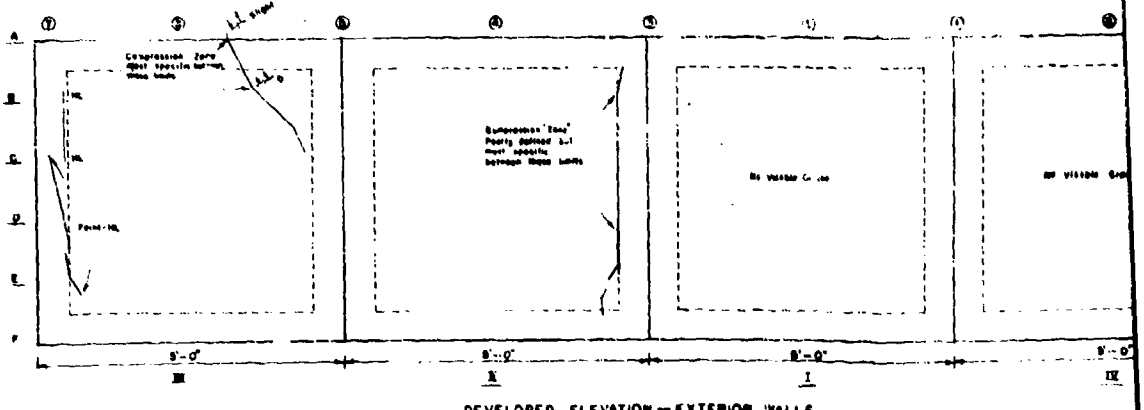
PLAN — ROOF SLAB — BOTTOM — (MIRROR VIEW)
SCALE: 1" = 1'-0"



PLAN
SCALE: 1" = 1'-0"

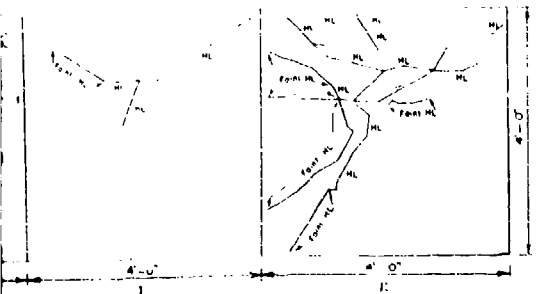


PLAN — BASE SLA
SCALE: 1" = 1

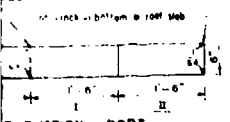


DEVELOPED ELEVATION — EXTERIOR WALLS
SCALE: 1" = 1'-0"

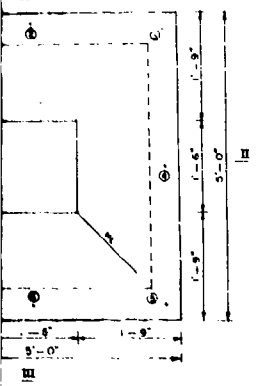
U. S. ARMY



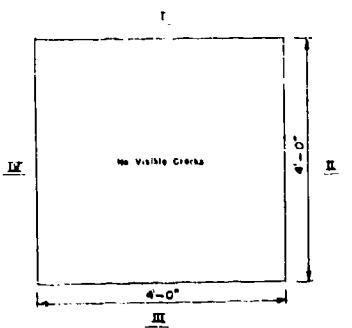
ATION - INTERIOR WALLS
SCALE 1" = 1'-0"



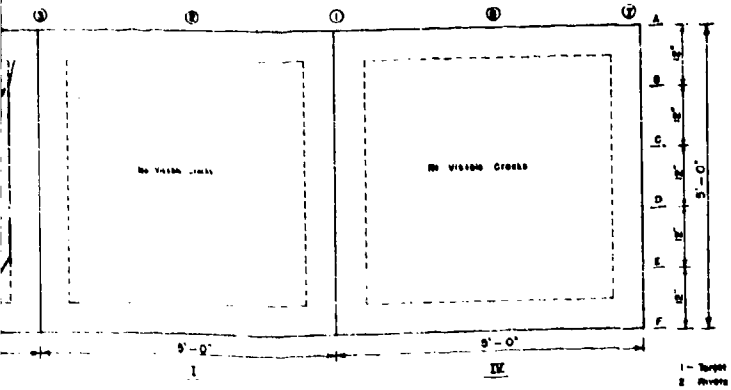
ELEVATION - PORT
SCALE 1" = 1'-0"



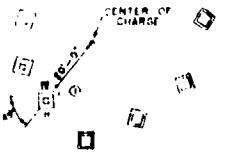
PLAN
SCALE 1" = 1'-0"



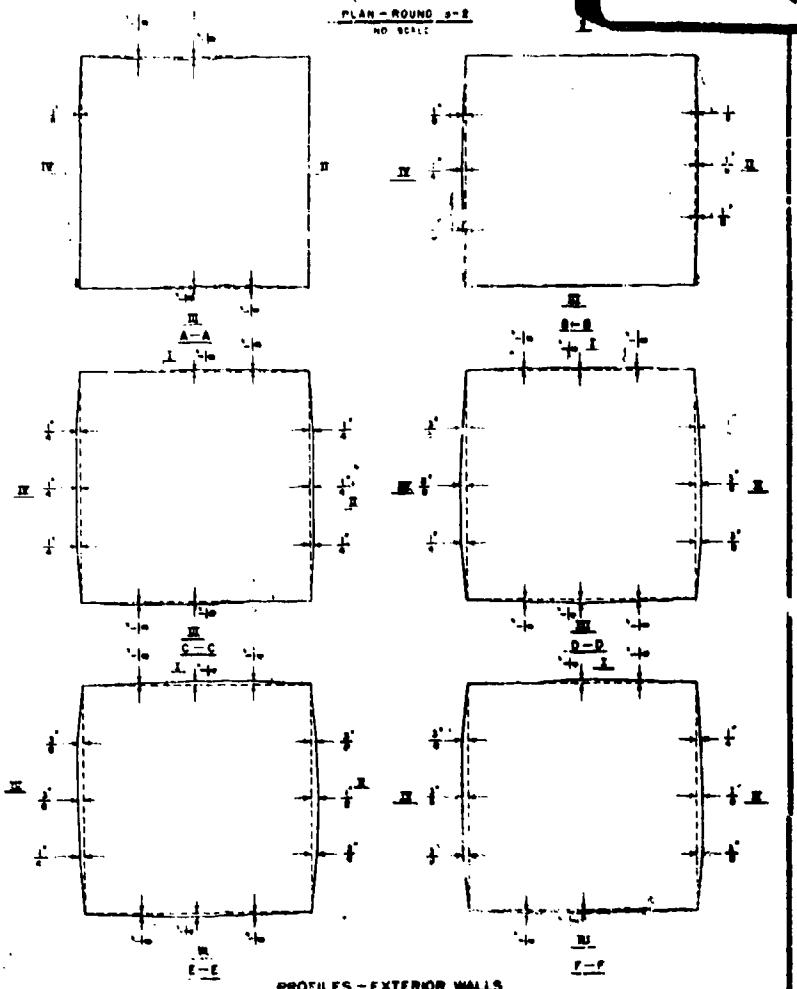
PLAN - BASE SLAB - INTERIOR
SCALE 1" = 1'-0"



ATION - EXTERIOR WALLS
SCALE 1" = 1'-0"



PLAN - ROUND S-2
NO SCALE



PROFILES - EXTERIOR WALLS
SCALES - PLAN - 1" = 1'-0"
DEFORMATION - 1/4" = 1'-0"

GRAPHIC SCALES

1" = 1'-0"
3/4" = 1'-0"
1/4" = 1'-0"

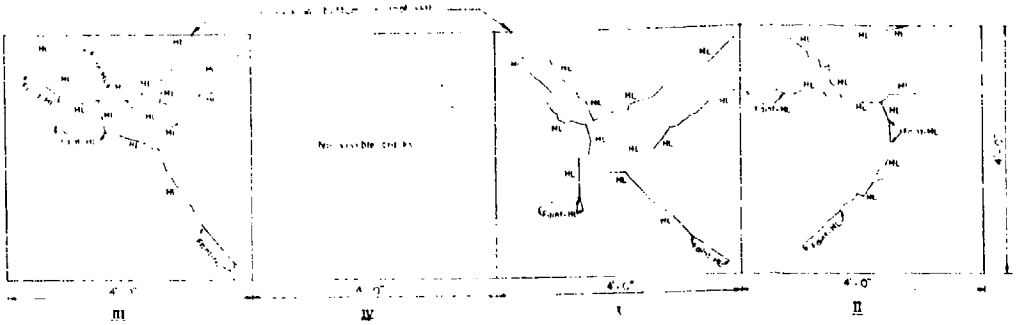
GENERAL NOTES

1 - Target faces are designated I, II, III, or IV clockwise.
2 - Rivets are numbered clockwise and designated O.
3 - Cracks and offsets of cracks are located to scale.
4 - Hair-line cracks (~ 1/64") are specified "HL".
5 - Crack sizes vary uniformly between the dimensions specified where size limits are not indicated.
6 - Crack offset symbols are shown in section.

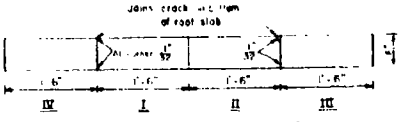
H.E.R.	UNDERGROUND EXPLOSION TESTS
R.A.	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
H.E.R.	ROUND S-2
	TARGET #-3
	CRACK PATTERNS & WALL DEFORMATION
FILED 1952	84-01-162

CONFIDENTIAL - SECURITY INFORMATION

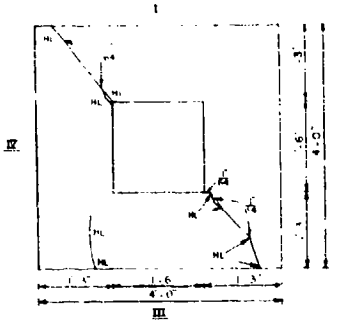
PLATE IX



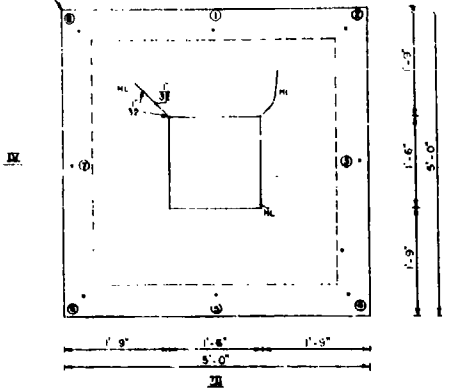
DEVELOPED ELEVATION – INTERIOR WALLS
SCALE: 1" = 1'-0"



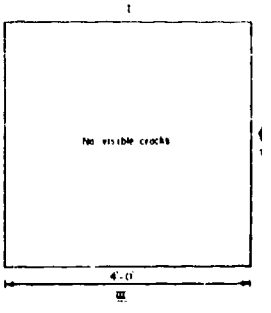
DEVELOPED ELEVATION – PORT
SCALE: 1" = 1'-0"



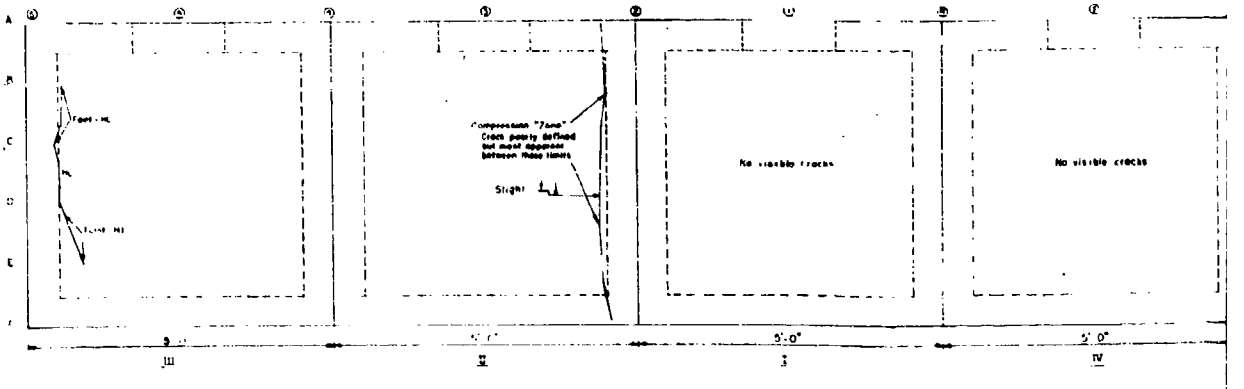
PLAN - ROOF SLAB - BOTTOM (MIRROR VIEW)
SCALE: 1" = 1'-0"



PLAN
SCALE: 1" = 1'-0"

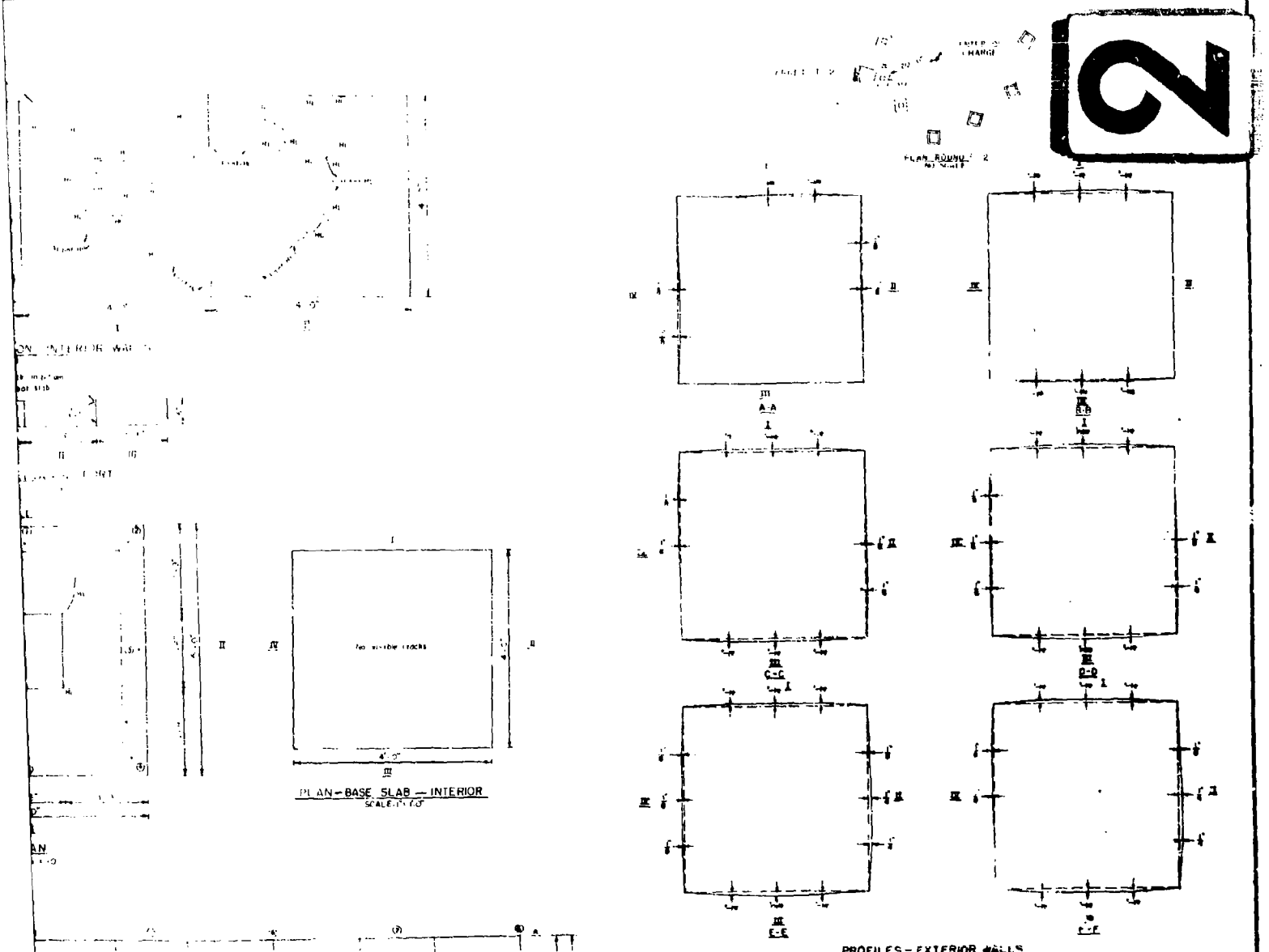


PLAN – BASE SLAB – INTERIOR
SCALE: 1" = 1'-0"



DEVELOPED ELEVATION EXTERIOR WALLS
SCALE: 1" = 1'-0"

U. S. ARMY



PLAN – BASE SLAB – INTERIOR
SCALE: 1" = 1'-0"

PROFILES – EXTERIOR WALLS
SCALES – PLAN – 1" = 1'-0"
DEFORMATION – 6" = 1'-0"

EXTERIOR WALLS

GRAPHIC SCALES

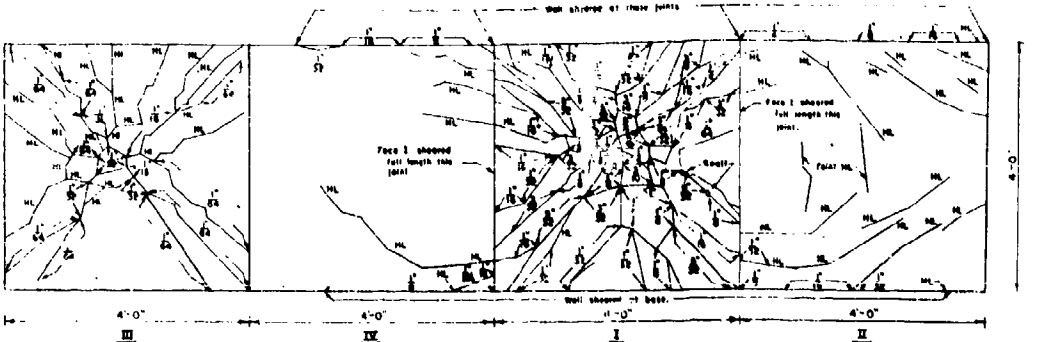
GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise.
2. Rivets are numbered clockwise and designated (-).
3. Cracks and offsets of cracks are located to scale.
4. Hair line cracks (-g-) are not specified.
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated.
6. Crack offset symbols are shown in section.

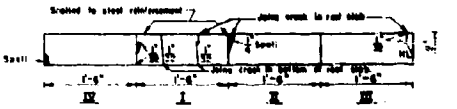
H.E.R.	UNDERGROUND EXPLOSION TESTS
	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
	ROUND S-2
H.E.R.	TARGET S-2
	CRACK PATTERNS & WALL DEFORMATION
AS SHOWN	
9 FEB 1955	84-01-162

CONFIDENTIAL - SECURITY INFORMATION

PLATE X

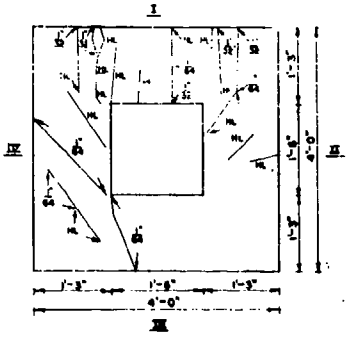


DEVELOPED ELEVATION — INTERIOR WALLS
SCALE 1"=1'-0"

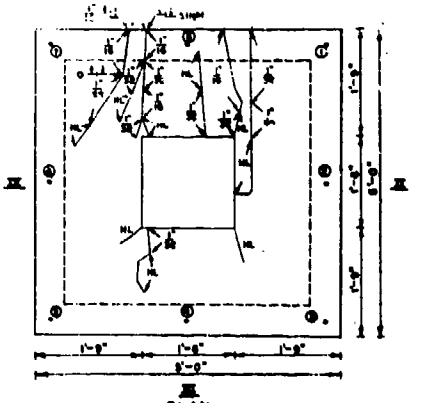


DEVELOPED ELEVATION—PORT
SCALE: 1"=1'-0"

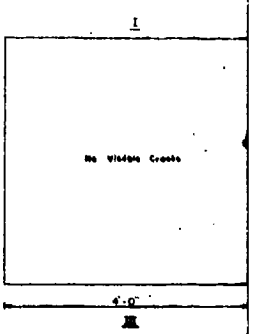
Note 6 Change 20'-0" perpendicular to ℄ of exterior of Face 1.



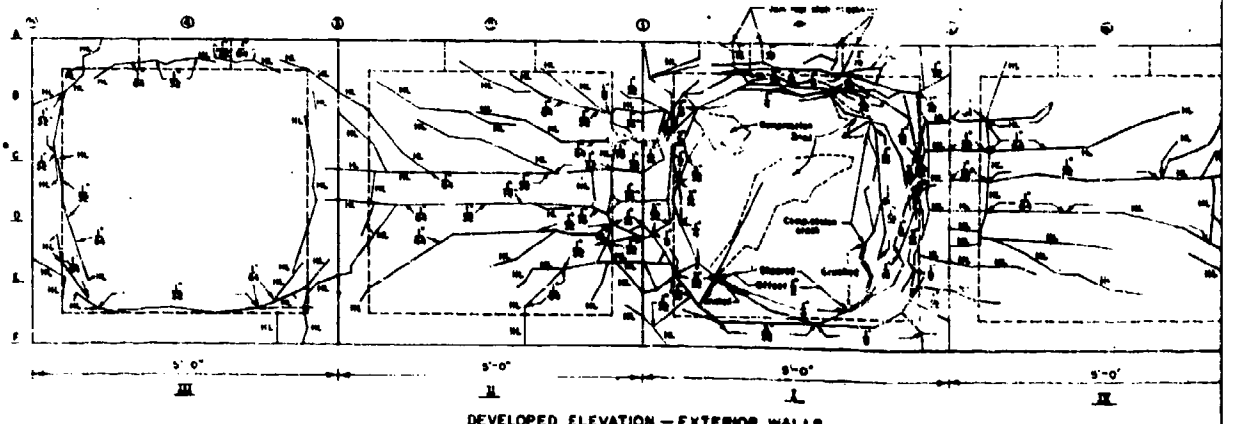
PLAN - ROOF SLAB - BOTTOM - (MIRROR VIEW)
SCALE 1"=1'-0"



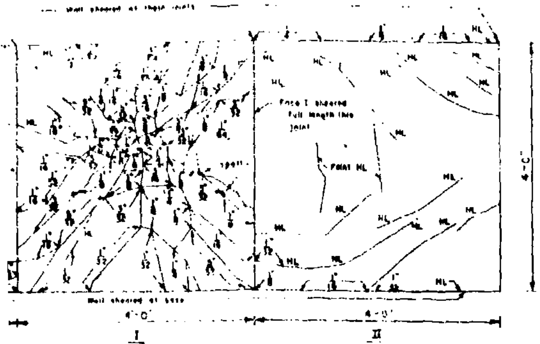
PLAN
SCALE: 1"=1'-0"



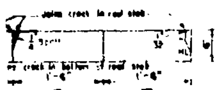
PLAN—BASE SLAB — INTERIOR
SCALE: 1"=1'-0"



DEVELOPED ELEVATION — EXTERIOR WALLS
SCALE: 1"=1'-0"

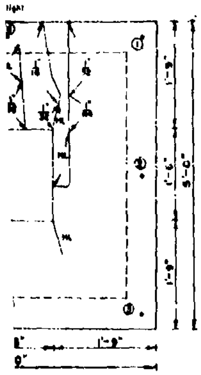


ON – INTERIOR WALLS
1" = 1'-0"

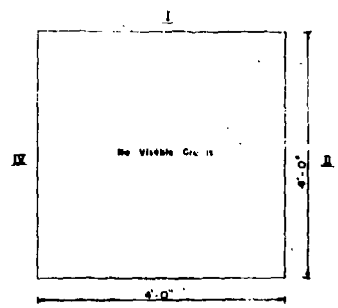


EVATION – PORT

Note ℄ Charge 20-0" perpendicular to ℄ of exterior of Face I.

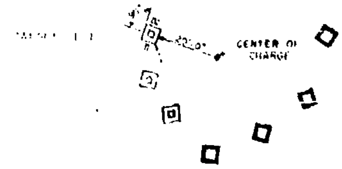


AN
1" = 1'-0"

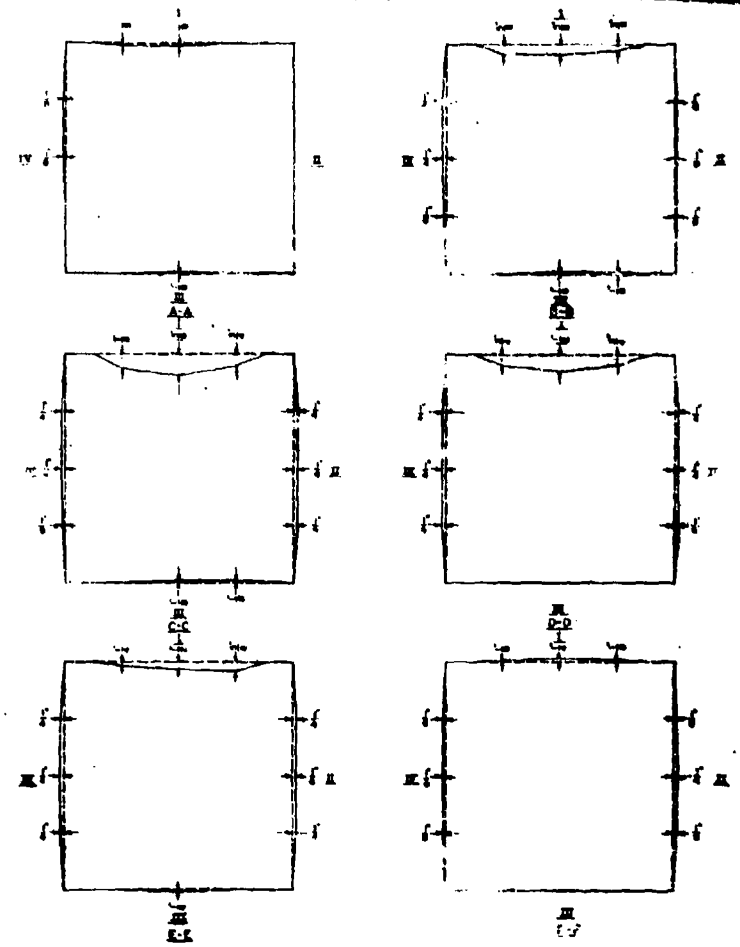


PLAN – BASE SLAB – INTERIOR
SCALE: 1" = 1'-0"

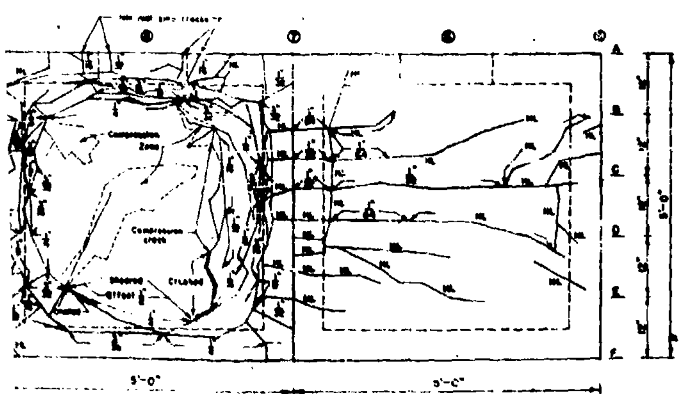
Note: Only the primary crack systems are shown.
All crack sizes not specified are 1/16" or less.



PLAN – ROUND S-2
NO SCALE

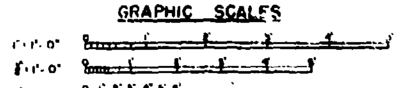


PROFILES – EXTERIOR WALLS
SCALES: PLAN 1" = 1'-0"
DEFORMATION 1" = 0'-1"



–EXTERIOR WALLS
1" = 1'-0"

GRAPHIC SCALES



GENERAL NOTES

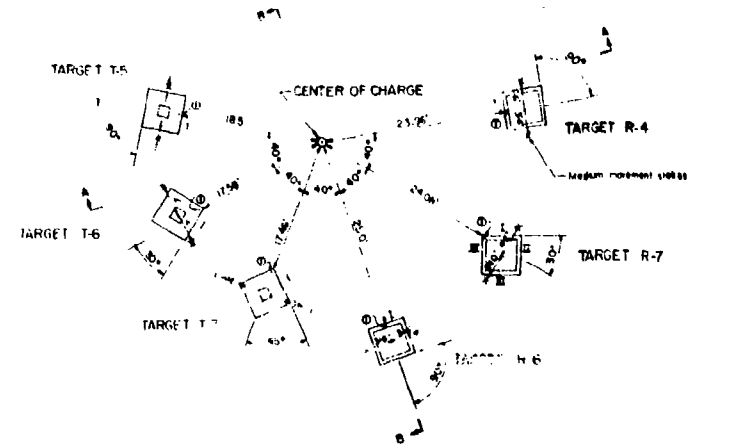
1. Target faces are designated I, II, IV, or III clockwise.
2. Rivets are numbered clockwise and designated ○.
3. Cracks and offsets of cracks are located to scale.
4. Hair-line cracks (< 1/64") are specified "HL".
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated.
6. Crack offset symbols are shown in section.

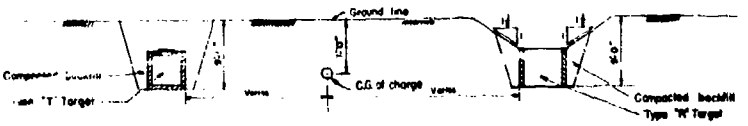
	UNDERGROUND EXPLOSION TESTS
H.E.R.	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
R.L.	ROUND S-2
H.E.R.	TARGET T-1
	CRACK PATTERNS & WALL DEFORMATION

21 FEB 1952

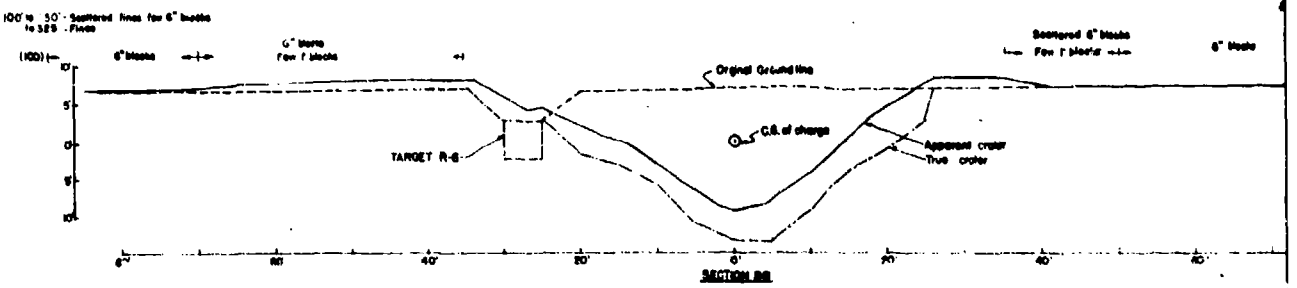
94-01-162



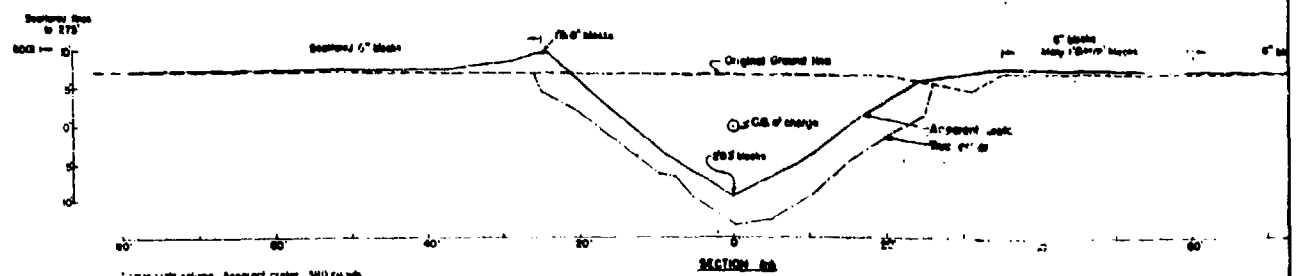




TYPICAL ORIGINAL SECTION

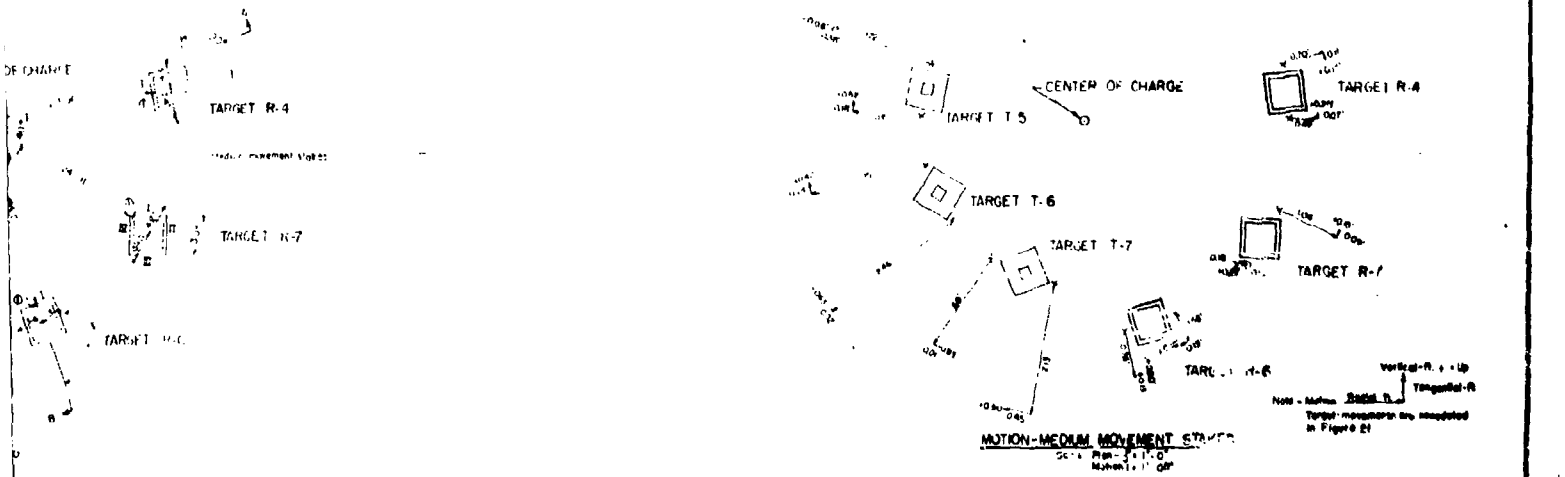


SECTION BB

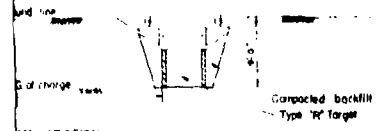


SECTION AA

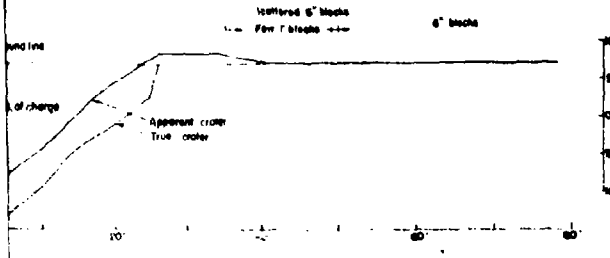
CRATER SECTIONS

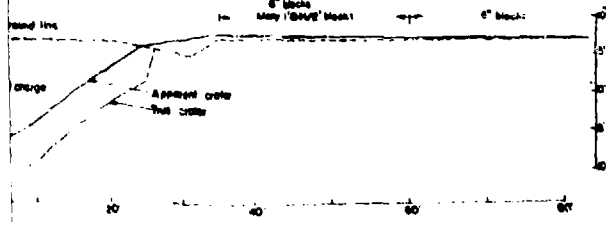


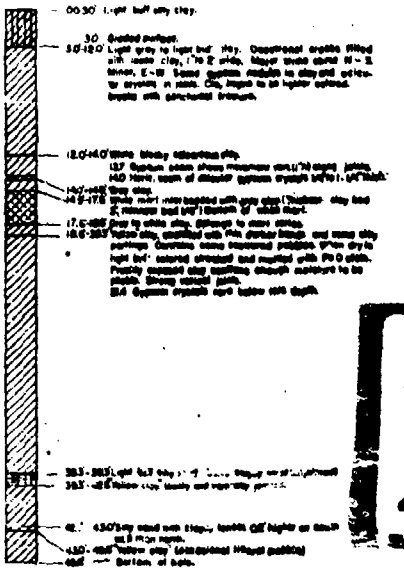
MOTION-MEDIUM MOVEMENT STAKES



AL SECTION







TYPICAL BORING LOG -- DRY CLAY AREA

GRAPHIC SCALES

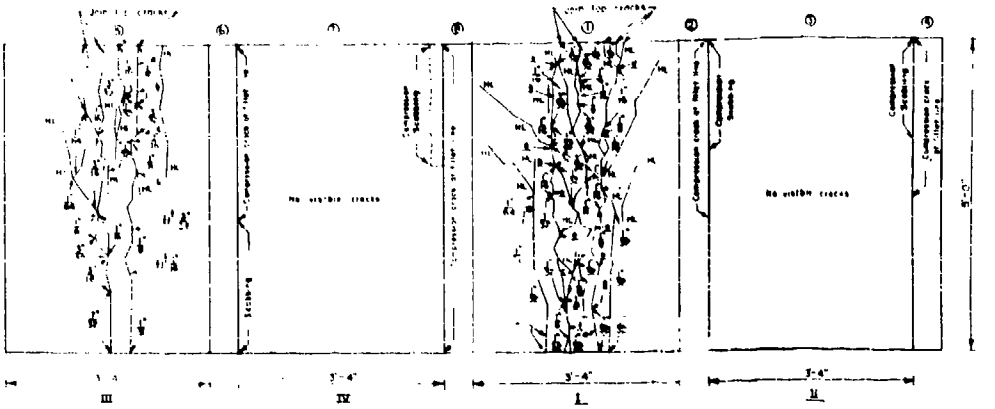
GENERAL NOTES

1. Target faces are designated I, II, III, IV clockwise
2. Rivets are numbered clockwise and designated ⊕

UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM
ROUND S-3
PLANS AND SECTIONS

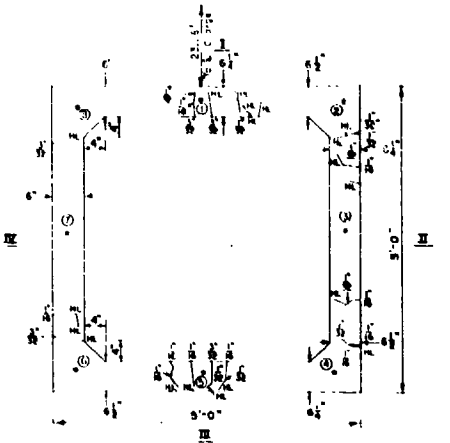
CONFIDENTIAL - SECURITY INFORMATION

PLATE 2



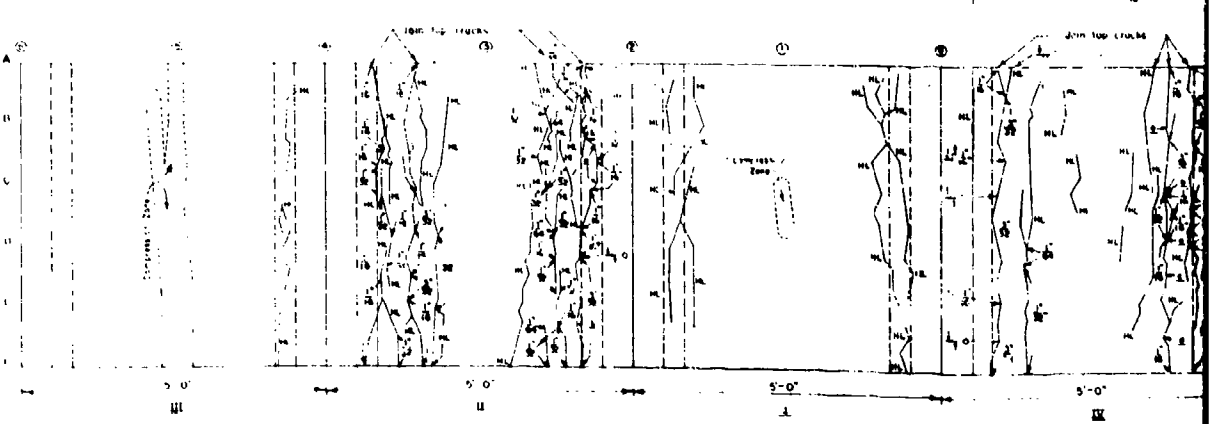
DEVELOPED ELEVATION — INTERIOR WALLS

SCALE 1"=1'-0"



PLAN

SCALE 1"=1'-0"

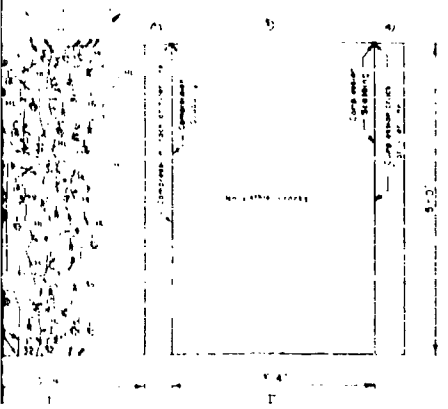


DEVELOPED ELEVATION — EXTERIOR WALLS

SCALE 1" = 1'-0"

U. S. ARMY

2

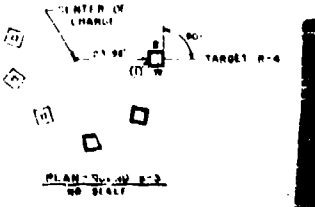


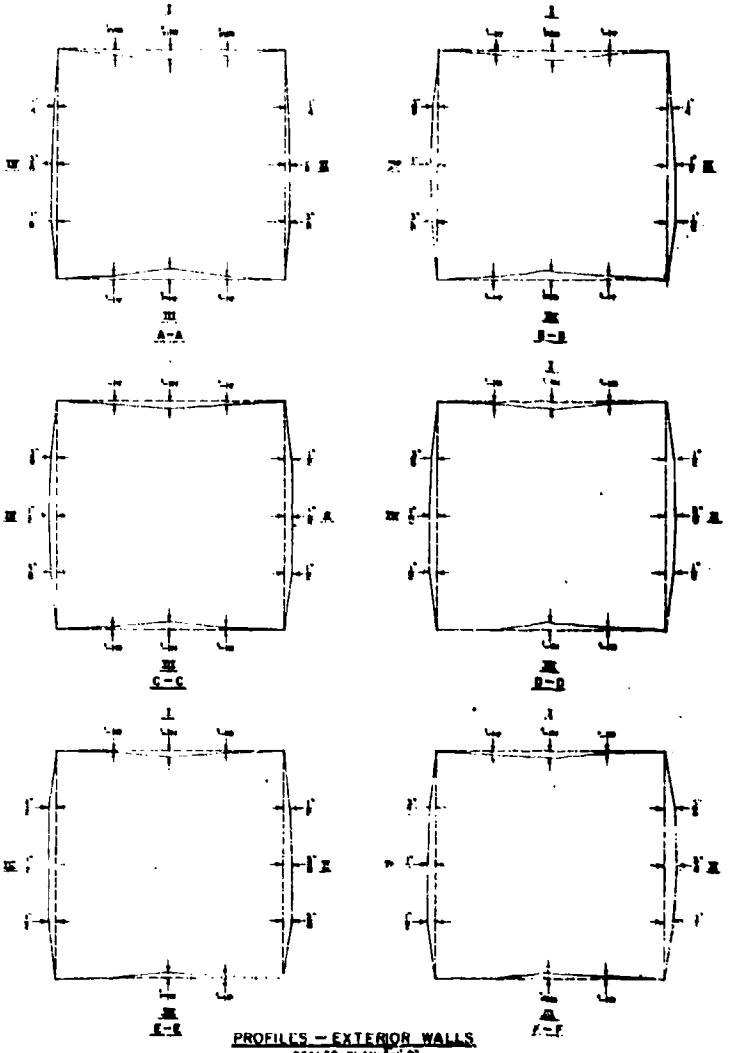
TERIOR WALLS





TERIOR WALLS





PROFILES — EXTERIOR WALLS

SCALES: PLAN 1/4"=1'-0"
DEFORMATION: 1/4" = 1'-0"

GRAPHIC SCALES

1"=1'-0"
1/2"=1'-0"
1/4"=1'-0"

GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise
2. Rivets are numbered clockwise and designated ○
3. Cracks and offsets at cracks are located to scale
4. [illegible] rockwell gauges are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated
6. Crack offset symbols are shown in section

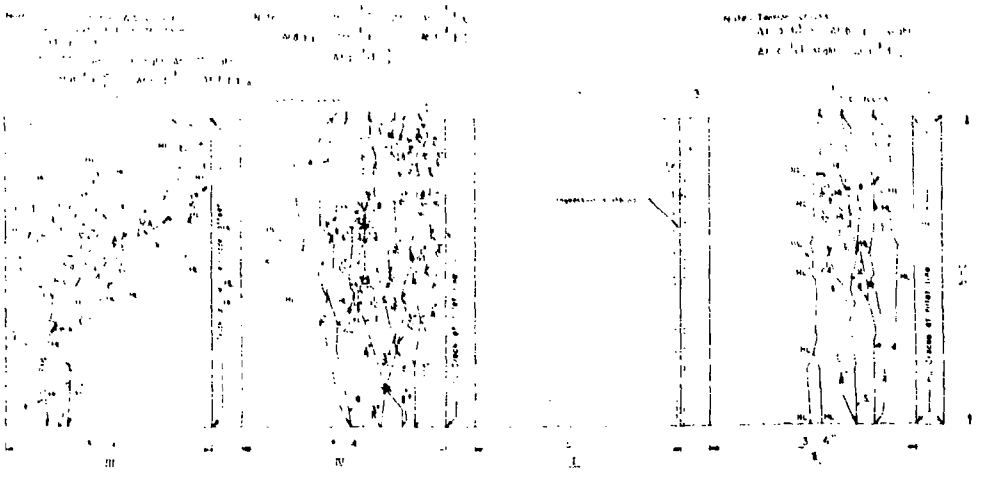
DES.	HER
DRN.	B.L.
TRC.	W.H.P.
SUBMITTED	
APPROVED	
DATE	21 FEB 1952

UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM
ROUND 3-3
TARGET R-4
CRACK PATTERNS & WALL DEFORMATIONS

AS SHOWN

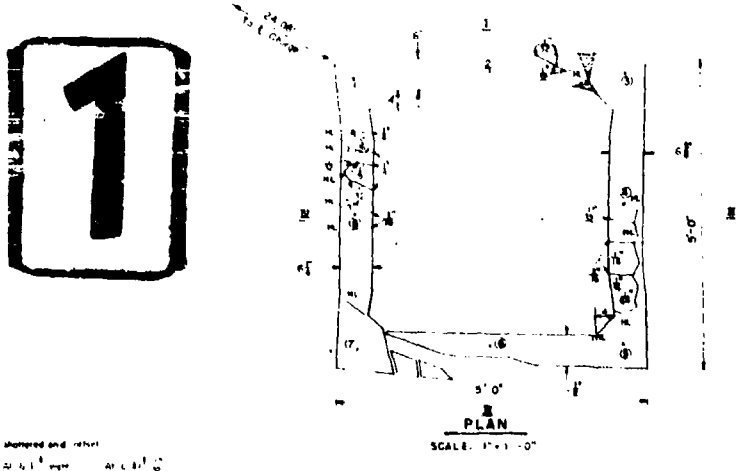
DRAWING NO.	86-01-162

CONFIDENTIAL – SECURITY INFORMATION PLATE XIII



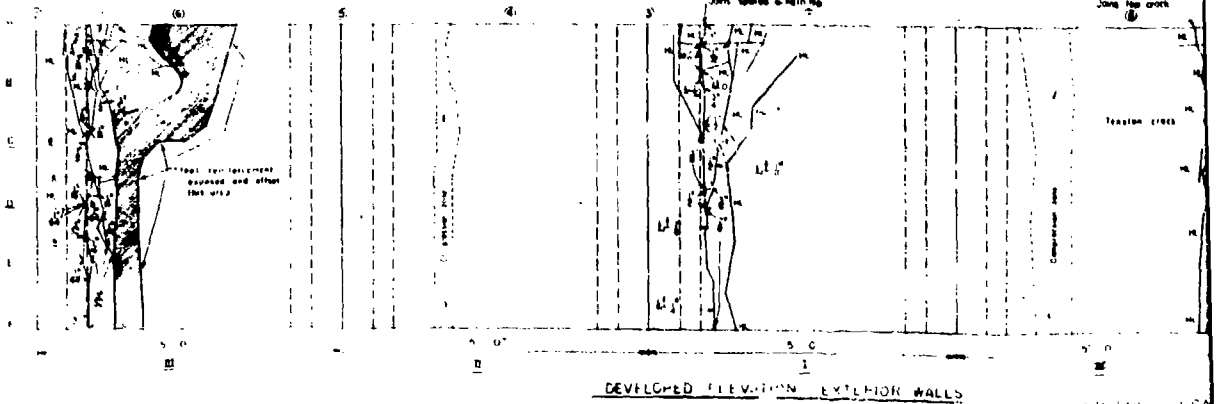
DEVELOPED ELEVATION — INTERIOR WALLS

SCALE 1" = 1'-0"



PLAN

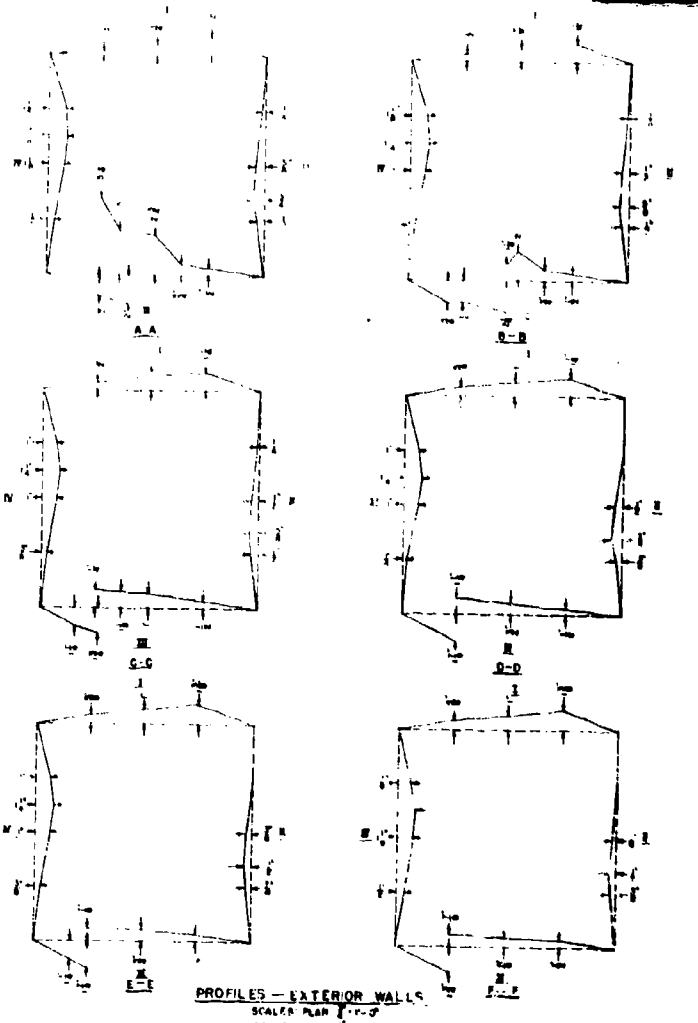
SCALE 1" = 1'-0"



DEVELOPED ELEVATION — EXTERIOR WALLS

U. S. ARMY

2



PROFILES — EXTERIOR WALLS

SCALES: PLAN 1"=5'
DEFORMATION 1"=1'-0"

GENERAL NOTES

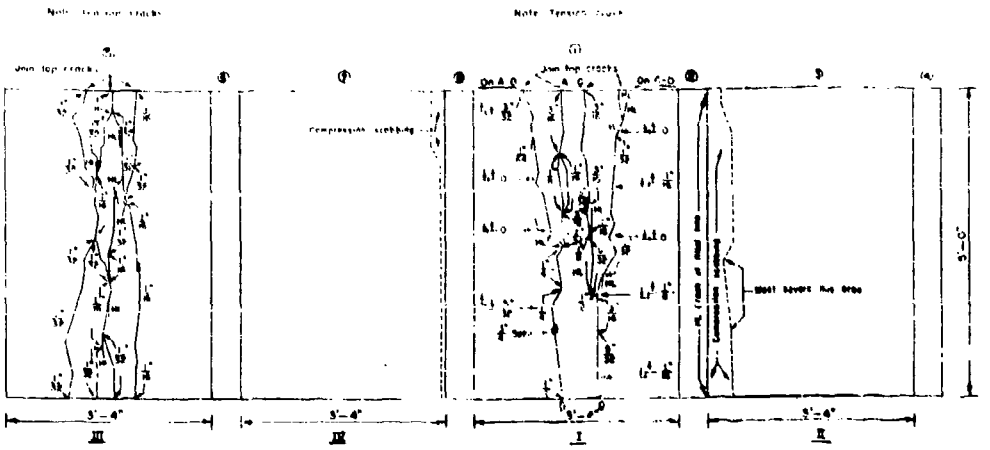
1. Target faces are designated I, II, III, or IV clockwise
2. Rivets are numbered clockwise and designated ○
3. Cracks and offsets of cracks are located to scale.
4. Hairline cracks (.04) are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when sure limits are not indicated
6. Size of arrowhead symbols are shown in section
7. Areas covered to a required depth of steel reinforcement are shown thus

GRAPHIC SCALES

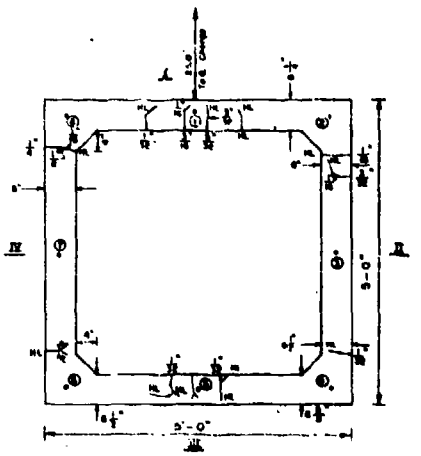
DRAWN	H.E.R.	UNDERGROUND EXPLOSION TESTS
TRACED	D.L.	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
CHECKED	H.E.R.	ROUND S 3
SUBMITTED		TARGET IV-W
		CRACK PATTERNS & WALL DEFORMATIONS
		DRAWING NO. 84-01-162

CONFIDENTIAL - SECURITY INFORMATION

PLATE XIV

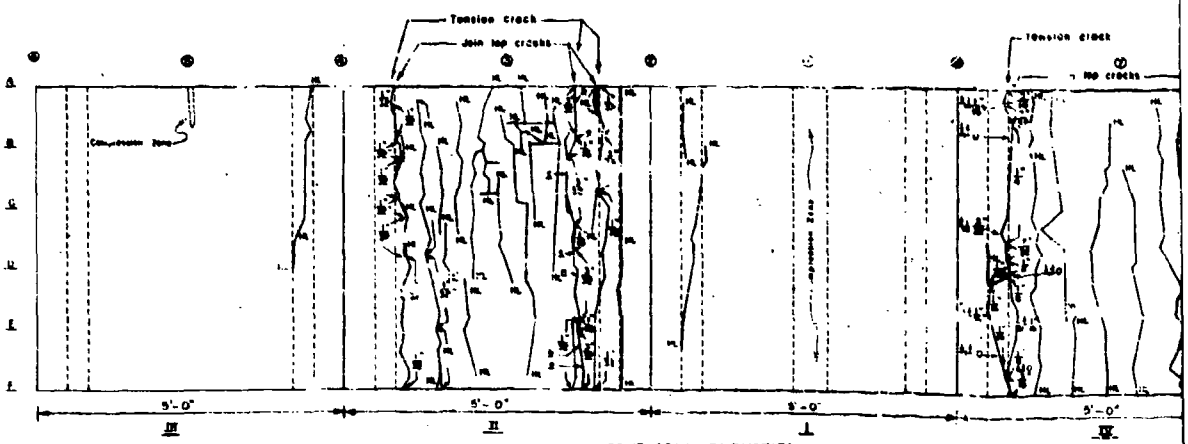


DEVELOPED ELEVATION — INTERIOR WALLS
SCALE: 1"=1'-0"



PLAN
SCALE: 1"=1'-0"

Note. At a [illegible] At b [illegible] At c [illegible]



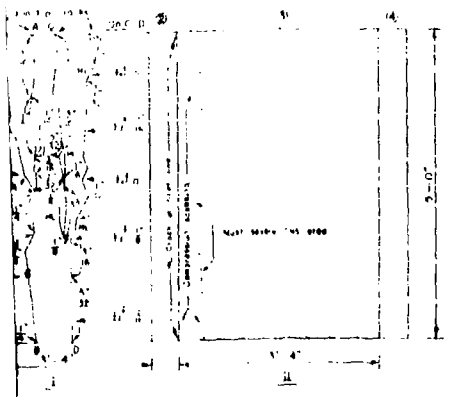
DEVELOPED ELEVATION — EXTERIOR WALLS
SCALE: 1"=1'-0"

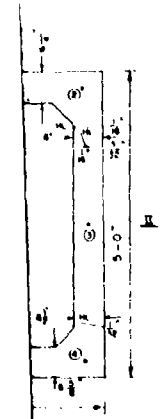
GRAPHIC

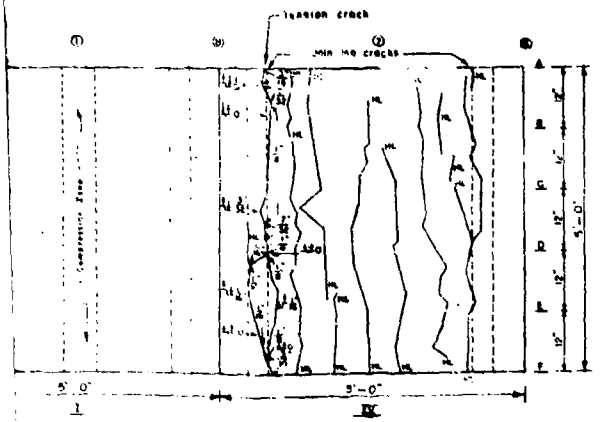
1"=1'-0"
3/4"=1'-0"
1/4"=1'-0"

U. S. ARMY

2

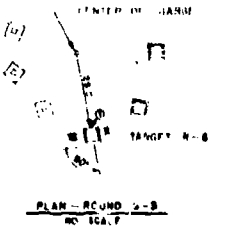




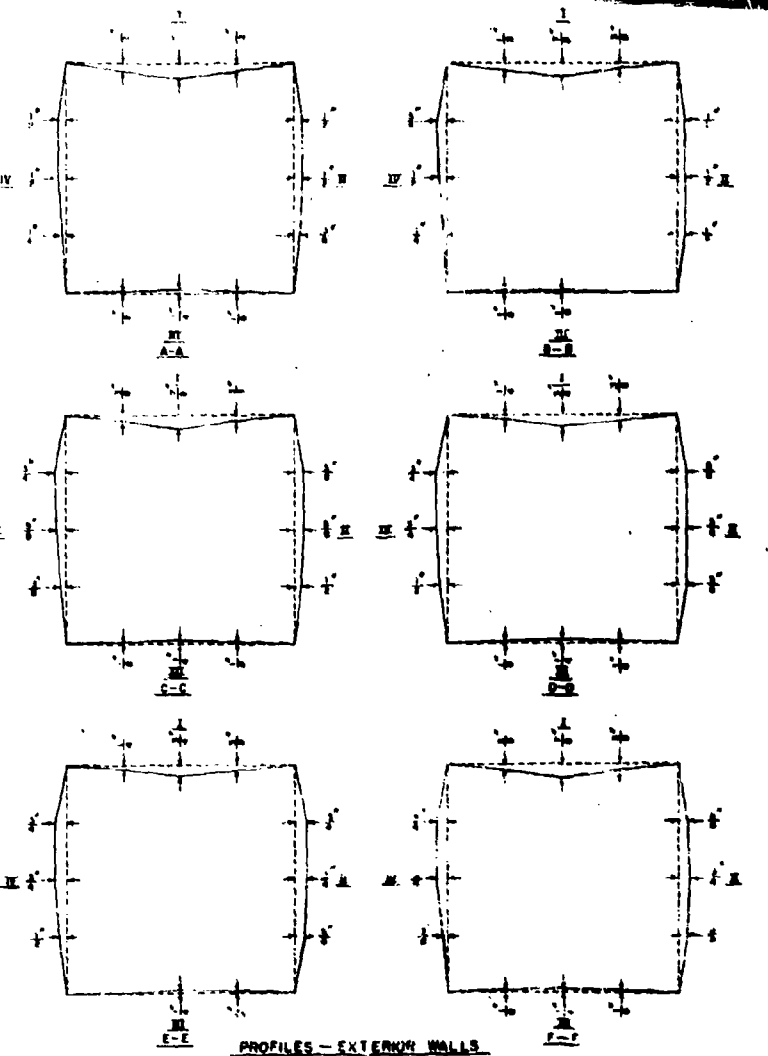


VATION – EXTERIOR WALLS

GRAPHIC SCALES



PLAN – ROUND 5-8



PROFILES – EXTERIOR WALLS

SCALES: PLAN 1/4"=1'-0"
DEFORMATION 1/4"=1'-0"

GENERAL NOTES

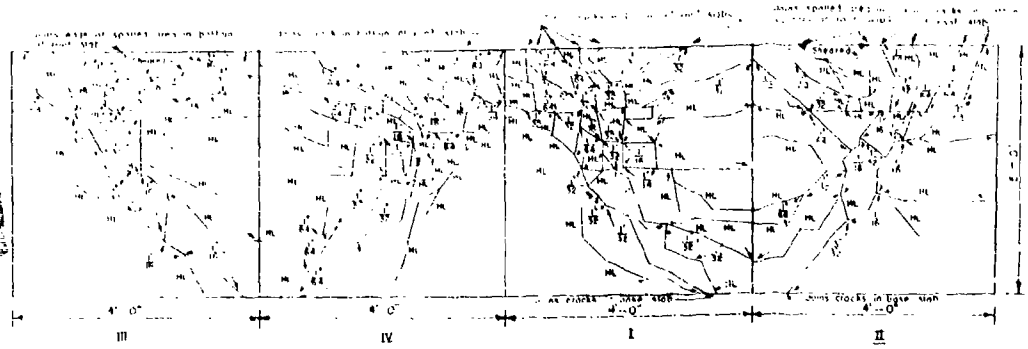
1. Target faces are given ... I, II, III, or IV clockwise.
2. Rivets are numbered clockwise and designated O.
3. Cracks and offsets of cracks are located as shown.
4. Hair-line cracks (...) are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when size limits are not indicated.

6. Crack other symbols are shown in section ...

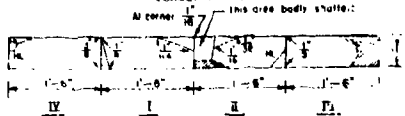
	UNDERGROUND EXPLOSION TESTS
H.E.R.	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
M.A.	ROUND 5-7
H.E.R.	TARGET P-6
	CRACK PATTERNS & WALL DEFORMATION
	DNA 84-01-162

CONFIDENTIAL - SECURITY INFORMATION PLATE XV

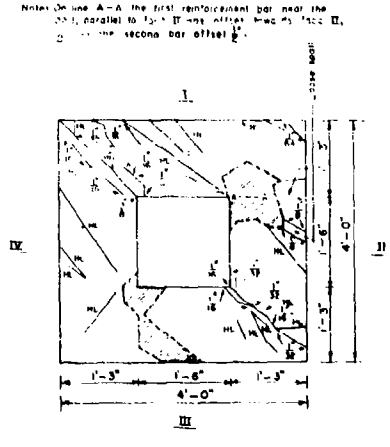
1



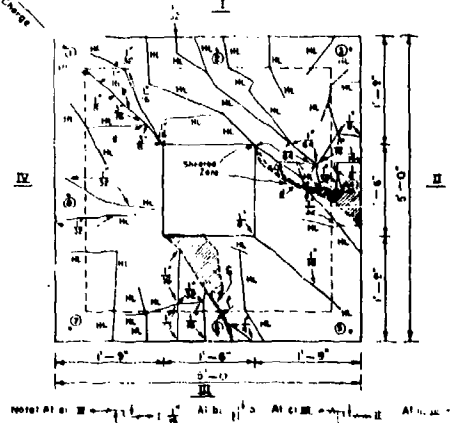
DEVELOPED ELEVATION—INTERIOR



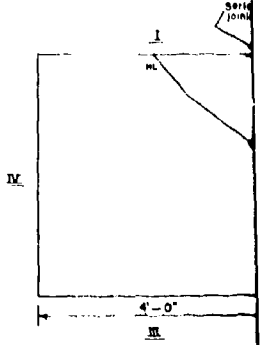
DEVELOPED ELEVATION—PORT
SCALE: 1" = 1'-0"



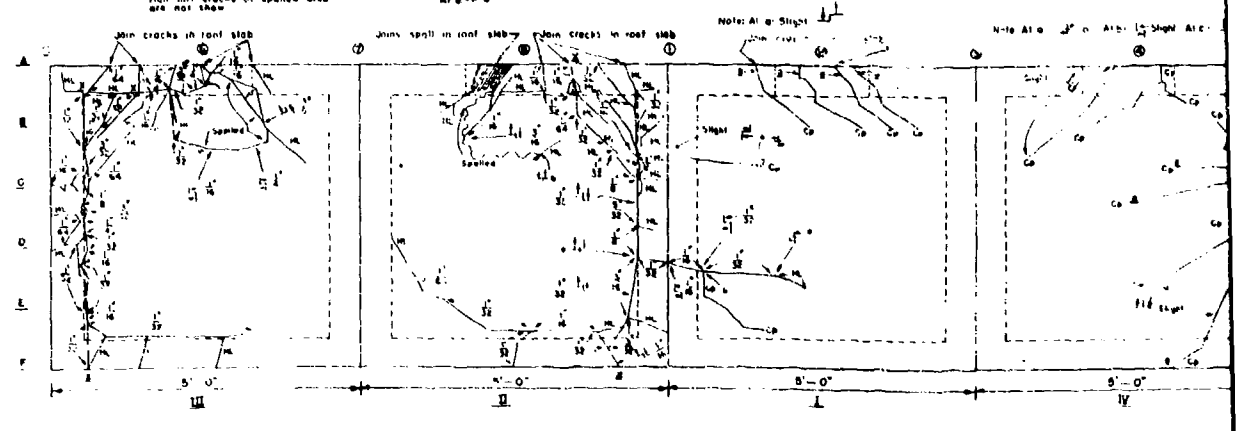
PLAN — ROOF SLAB — BOTTOM — (MIRROR VIEW)
SCALE: 1" = 1'-0"



PLAN
SCALE: 1" = 1'-0"

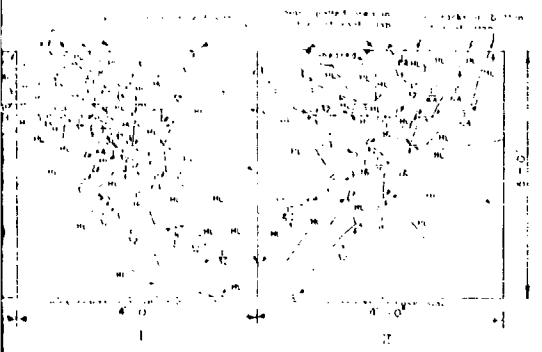


PLAN — BASE SLAB — INTER
SCALE: 1" = 1'-0"

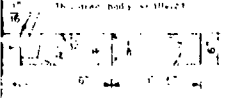


DEVELOPED ELEVATION — EXTERIOR WALLS
SCALE: 1" = 1'-0"

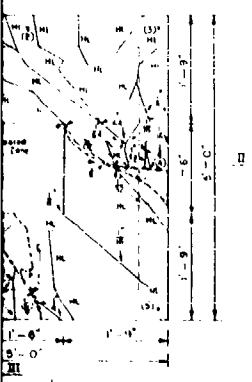
2



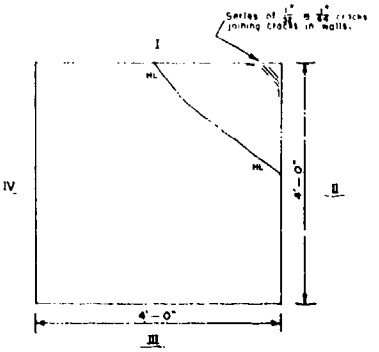
ATION – INTERIOR WALLS



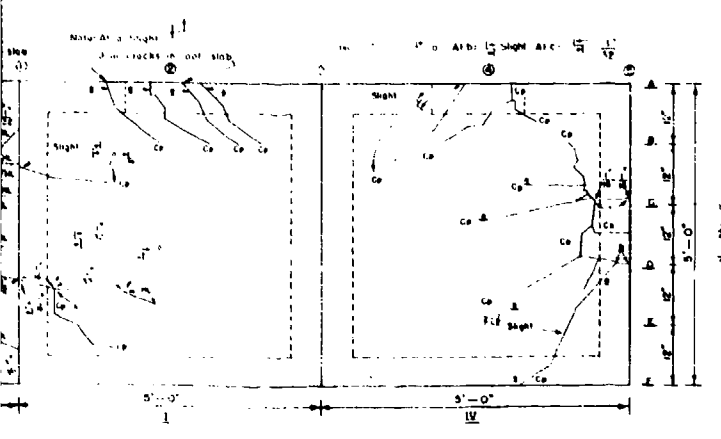
LEVATION – PORT



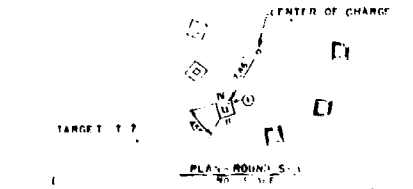
PLAN

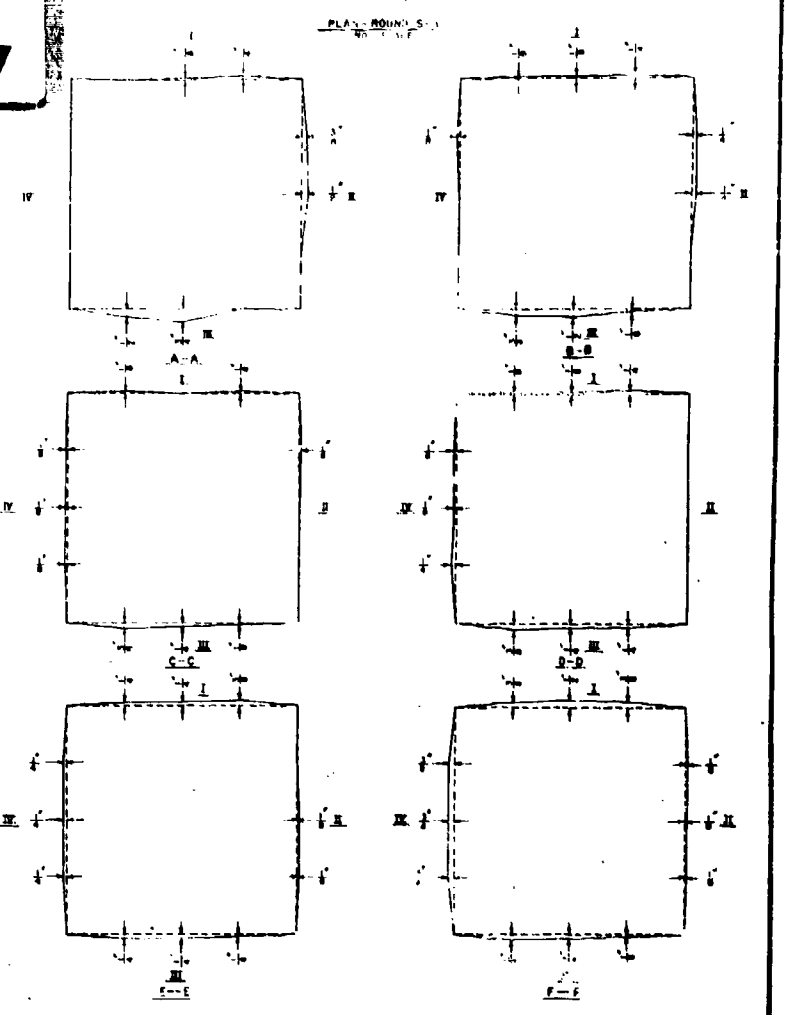


PLAN – BASE SLAB – INTERIOR
SCALE 1" = 1'-0"



LEVATION EXTERIOR WALLS





PROFILES – EXTERIOR WALLS
SCALE – PLAN 3/16" = 1'-0"
DEFORMATION 1/4" = 0'-1"

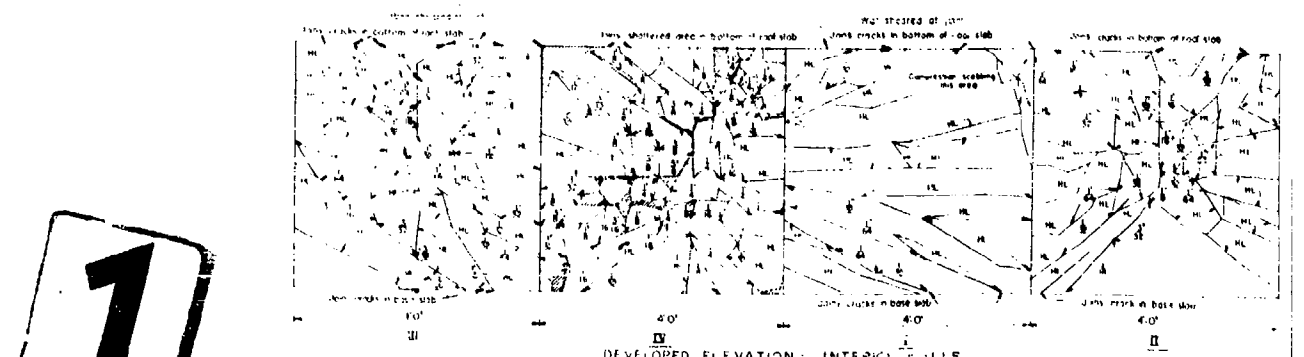
GRAPHIC SCALES

GENERAL NOTES

1 – Target faces are designated I, II, III, or IV clockwise.
2 – Rivets are numbered clockwise and designated ⊙
3 – Cracks and offsets at cracks are located to scale.
4 – Hairline cracks (1/64") are specified "HL".
5 – Crack sizes vary uniformly between the dimensions specified where size limits are not indicated.
6 – Cracks specified "Cp" are compression cracks, apparent, but poorly defined.
7 – Areas spalled to or beyond depth of steel reinforcement are shown thus: ▨
8 – Crack offset symbols are shown in sections:
Hor. Crack
Vert. Crack

DESIGNED: H.T.R.	UNDERGROUND EXPLOSION TESTS
DRAWN: M.A.	SUPPLEMENTARY SKEW STRUCTURES PROGRAM
CHECKED: H.T.S.	ROUND S-3
TRACED:	TARGET T-7
SUBMITTED:	CRACK PATTERNS & WALL DEFORMATION
APPROVED:	
DATE: 21 FEB. 1952	DRAWING NO. 64-01-162

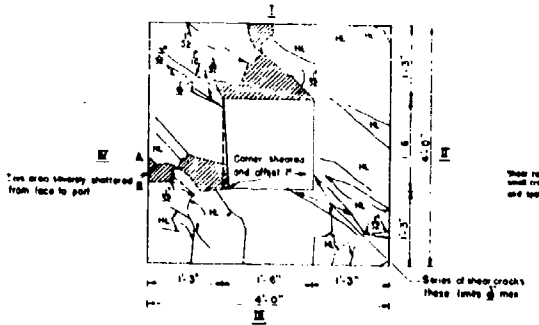
CONFIDENTIAL - SECURITY INFORMATION PLATE XVI



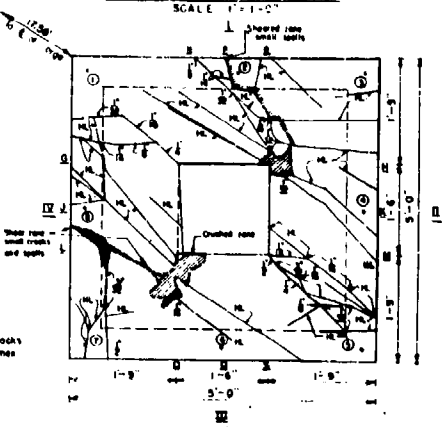
DEVELOPED ELEVATION - INTERIOR WALLS
SCALE 1"=1'-0"



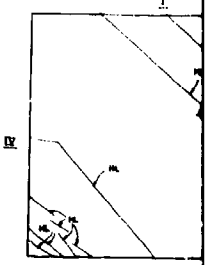
DEVELOPED ELEVATION - PORT
SCALE 1"=1'-0"



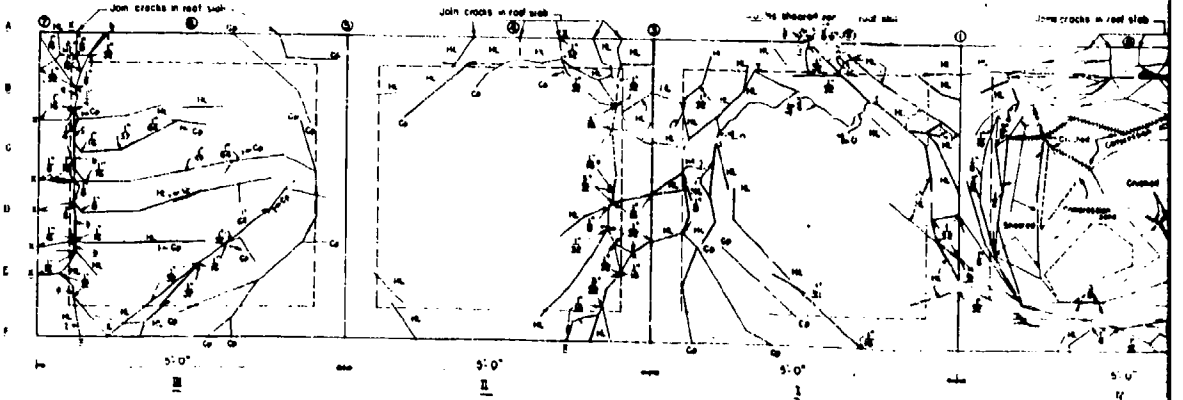
PLAN - ROOF SLAB BOTTOM - (MIRROR VIEW)
SCALE 1"=1'-0"



PLAN
SCALE 1"=1'-0"

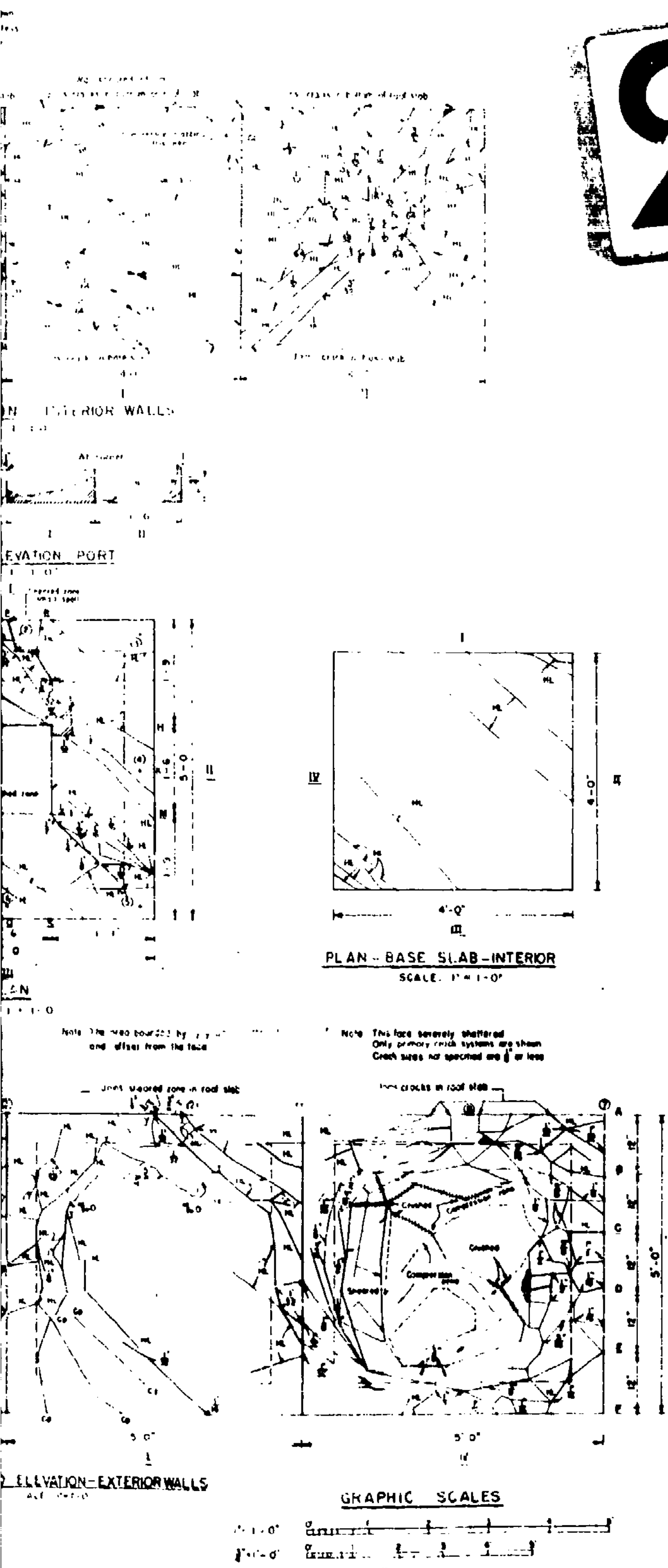


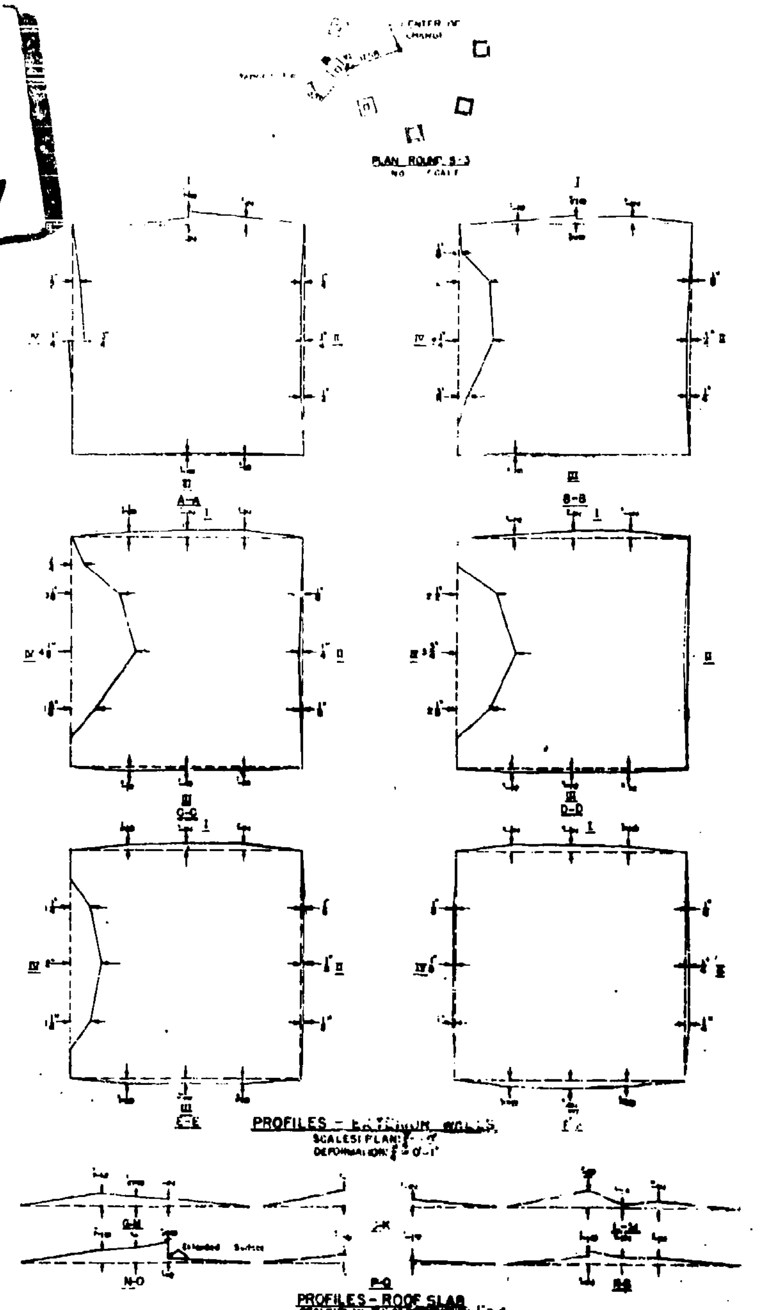
PLAN - BASE SLAB - IN
SCALE 1"=1'-0"



DEVELOPED ELEVATION - EXTERIOR WALLS
SCALE 1"=1'-0"

GRAPHIC SCALES





GENERAL NOTES

1. Target faces are designated I, II, III, or IV clockwise.
2. Rivets are numbered clockwise and designated ○.
3. Cracks and offsets of cracks are located to scale
4. Hair-line cracks (<1/64") are specified "HL"
5. Crack sizes vary uniformly between the dimensions specified when the limits are not indicated
6. Cracks specified "Cp" are compression cracks apparent, but poorly defined.
7. Areas spalled to or beyond depth of steel reinforcement are shown thus:
8. Crack offset symbols are shown in section.

H.E.R.

H.E.R.

UNDERGROUND EXPLOSION TESTS

SUPPLEMENTARY SKEW STRUCTURES PROGRAM

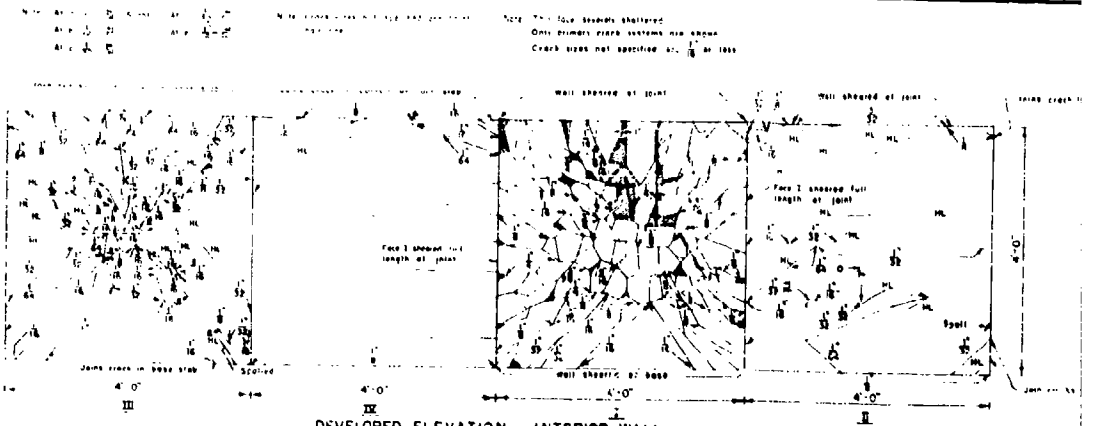
ROUND S-3

TARGET T-6

CRACK PATTERNS & WALL DEFORMATION

SCALE AS SHOWN

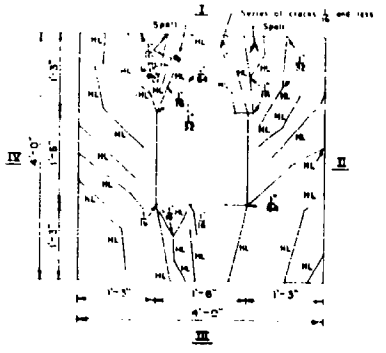
84-01-162



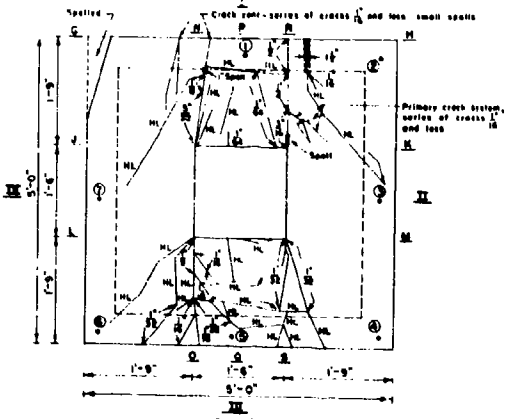
DEVELOPED ELEVATION — INTERIOR WALLS
SCALE 1" = 1'-0"



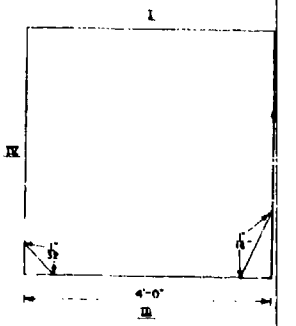
DEVELOPED ELEVATION — PORT
SCALE 1" = 1'-0"



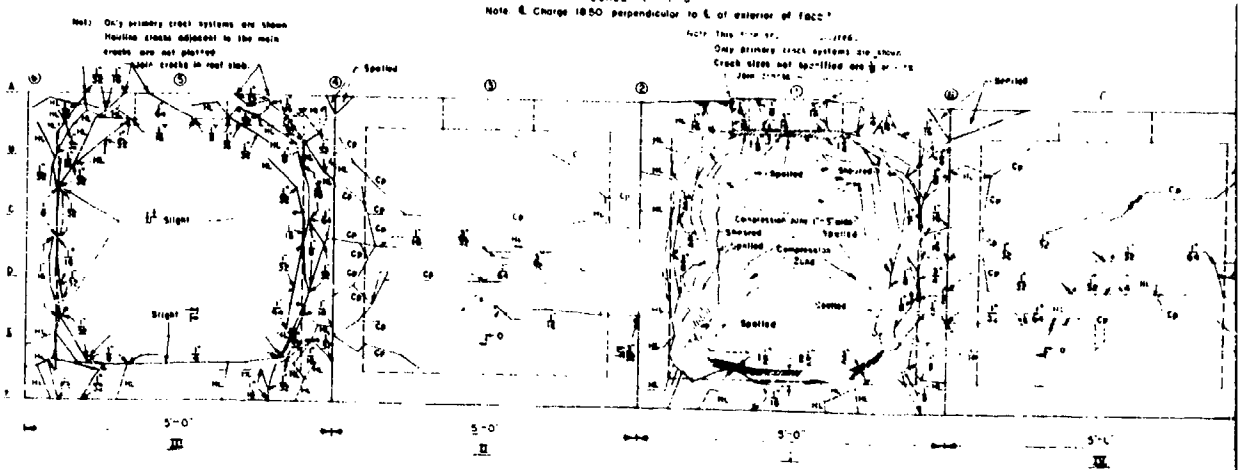
PLAN — ROOF SLAB BOTTOM — (MIRROR VIEW)
SCALE 1" = 1'-0"



PLAN
SCALE 1" = 1'-0"
Note: ℄ Charge 1850 perpendicular to ℄ of exterior of face

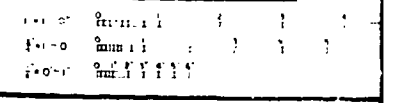


PLAN — BASE SLAB — INTERIOR
SCALE 1" = 1'-0"

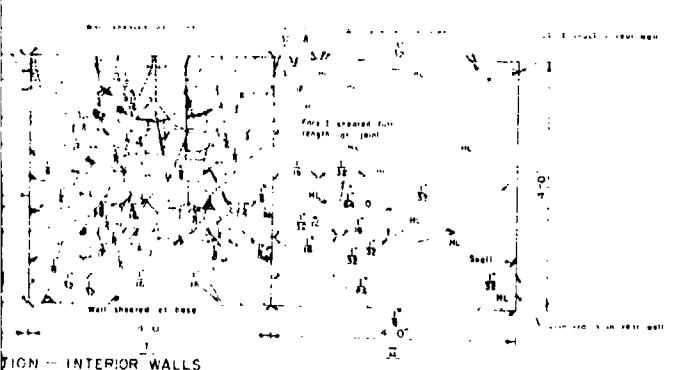


DEVELOPED ELEVATION — EXTERIOR WALLS
SCALE 1" = 1'-0"

GRAPHIC SCALES



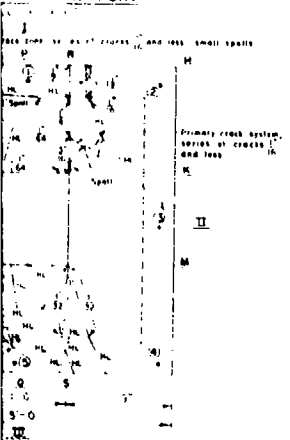
U. S. ARMY



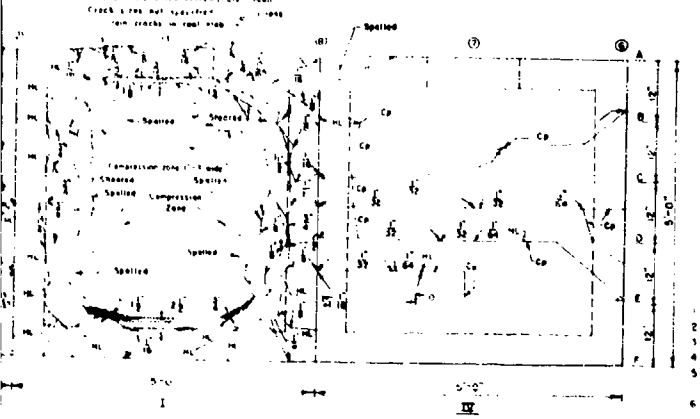
ION — INTERIOR WALLS



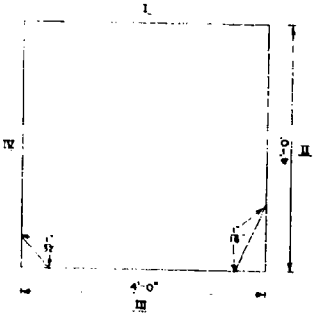
ELEVATION — PORT



PLAN

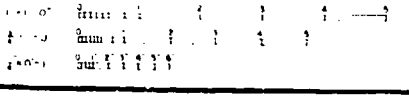


ON — EXTERIOR WALLS

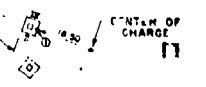


PLAN — BASE SLAB — INTERIOR
SCALE 1" = 1'-0"

GRAPHIC SCALES

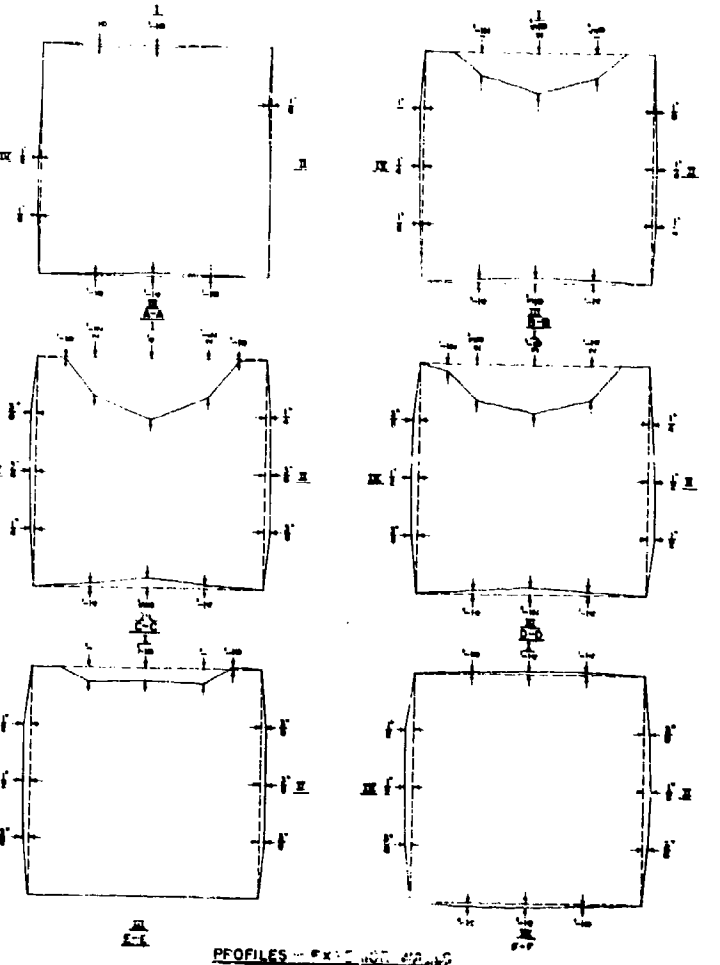


TARGET T-5

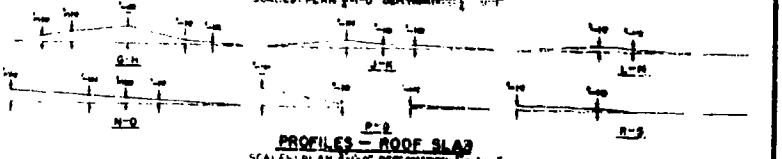


CENTER OF CHARGE

PLAN - ROUND S-3
NO SCALE



PROFILES — E-W
SCALES: PLAN 1"=1'-0" DEFORMATION



PROFILES — ROOF SLAB
SCALES: PLAN 1"=1'-0" DEFORMATION

GENERAL NOTES

1. Target faces are numbered I, II, III, or IV clockwise.
2. Rivets are numbered clockwise and designated O.
3. Cracks and offsets of cracks are located to scale.
4. Hairline cracks (< 1/16") are specified "HL".
5. Crack sizes vary uniformly between the dimensions specified where two limits are not indicated.
6. Inches specified "Cp" are compression cracks, apparent, but poorly defined.
7. Areas spalled in or beyond depth of steel reinforcement are shown thus [illegible].
8. Crack offset symbols are shown in section.

Hair Crack — Wall Crack

CORPS OF ENGINEERS, U. S. ARMY

DRAWN	H.E.R.
TRACED	
CHECKED	H.E.R.
APPROVED	

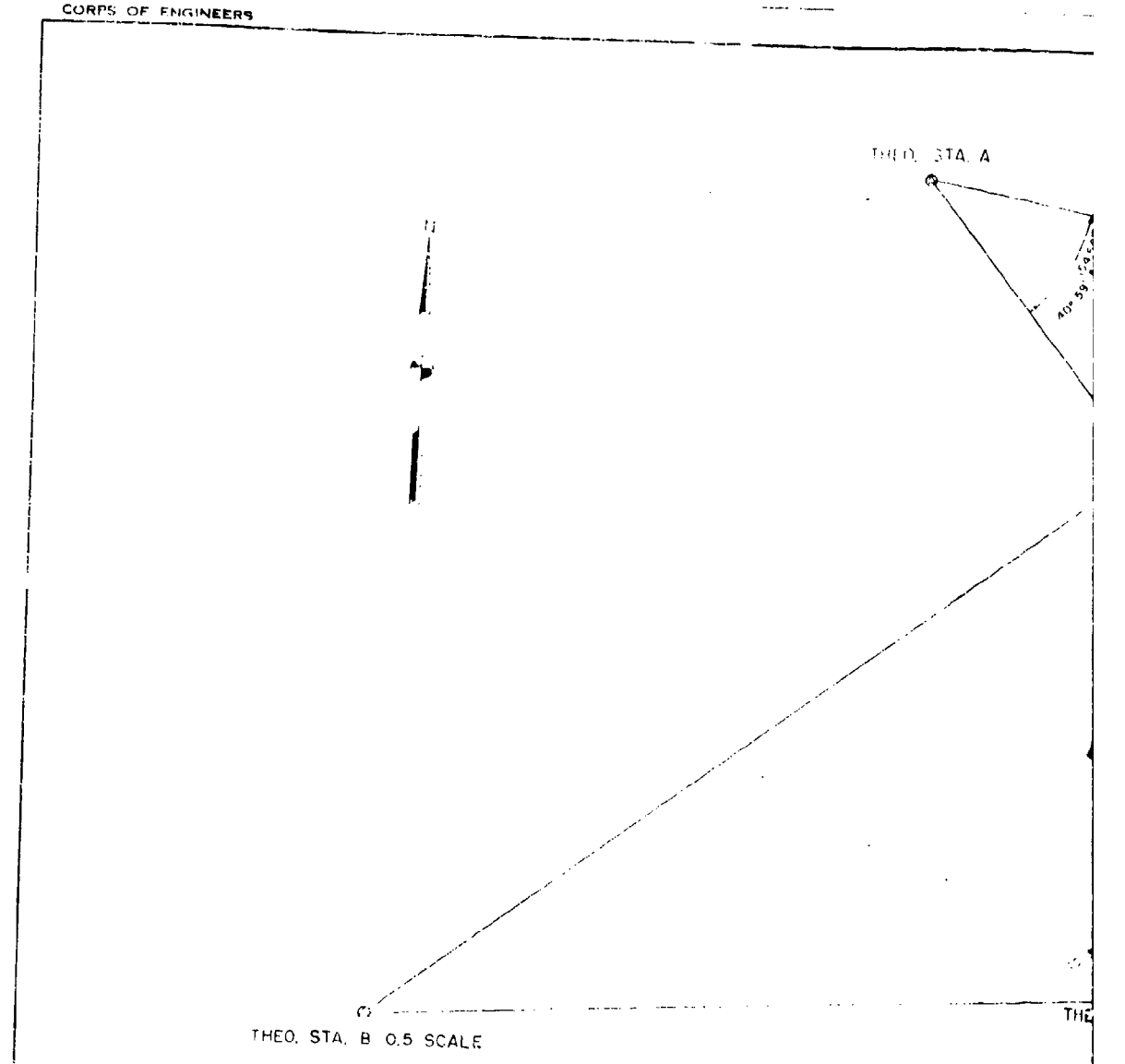
UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM
ROUND S-3
TARGET T-5
CRACK PATTERNS & WALL DEFORMATION

SCALE AS SHOWN
DATE 21 FEB 1962
FILE 84-01-162

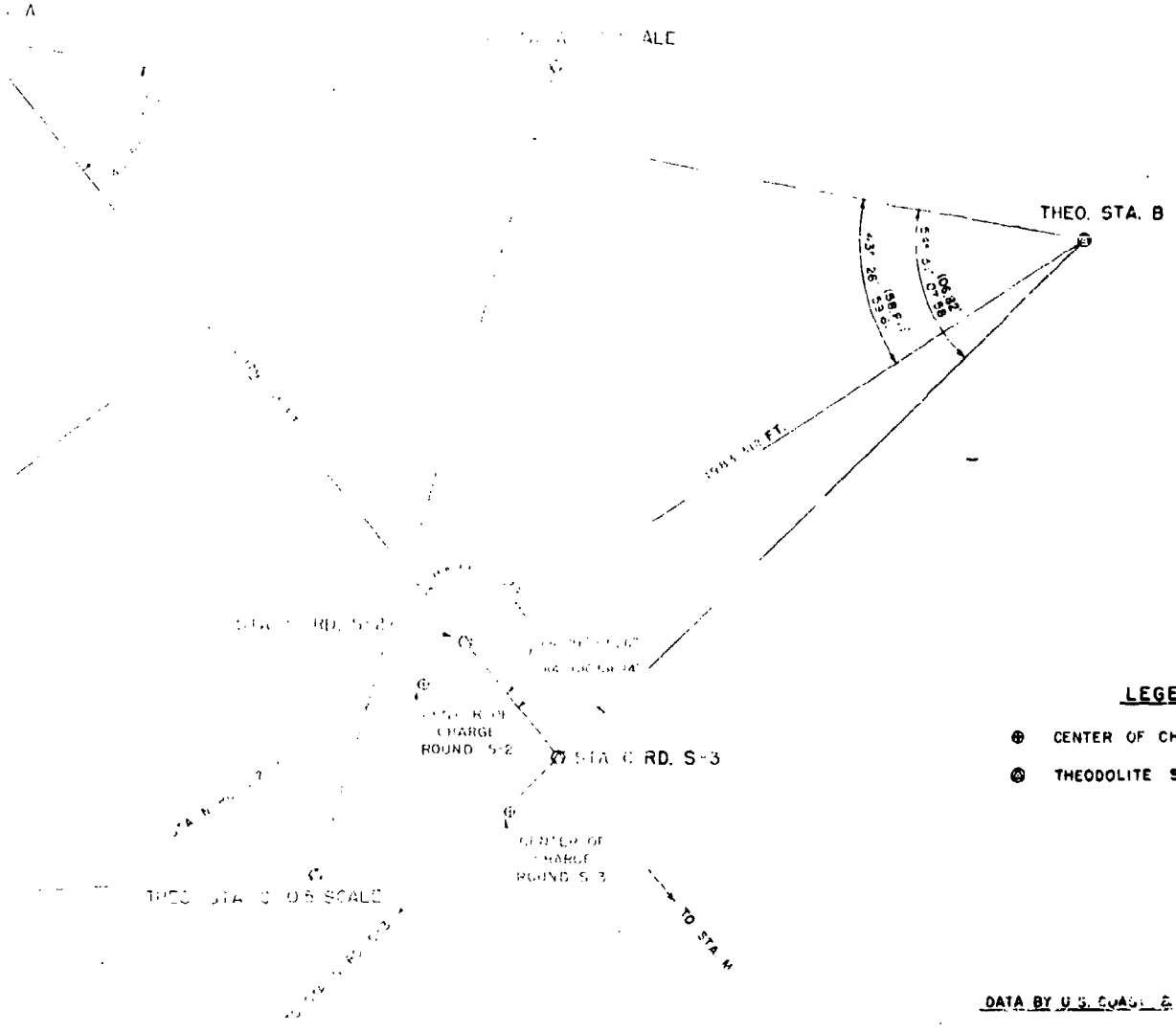
CONFIDENTIAL - SECURITY INFORMATION

PLATE XVIII

CORPS OF ENGINEERS



1



2

LEGEND

- ⊕ CENTER OF CHARGES.
- ◎ THEODOLITE STATIONS A, B & C.

DATA BY U. S. COAST & GEODETIC SURVEY

GRAPHIC SCALE

0 200' 400' 600' 800' 1000'

DIVISION	DATE	DESCRIPTION

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
SACRAMENTO DISTRICT
SACRAMENTO, CALIFORNIA

UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM
REPLACEMENT POINT LAYOUT

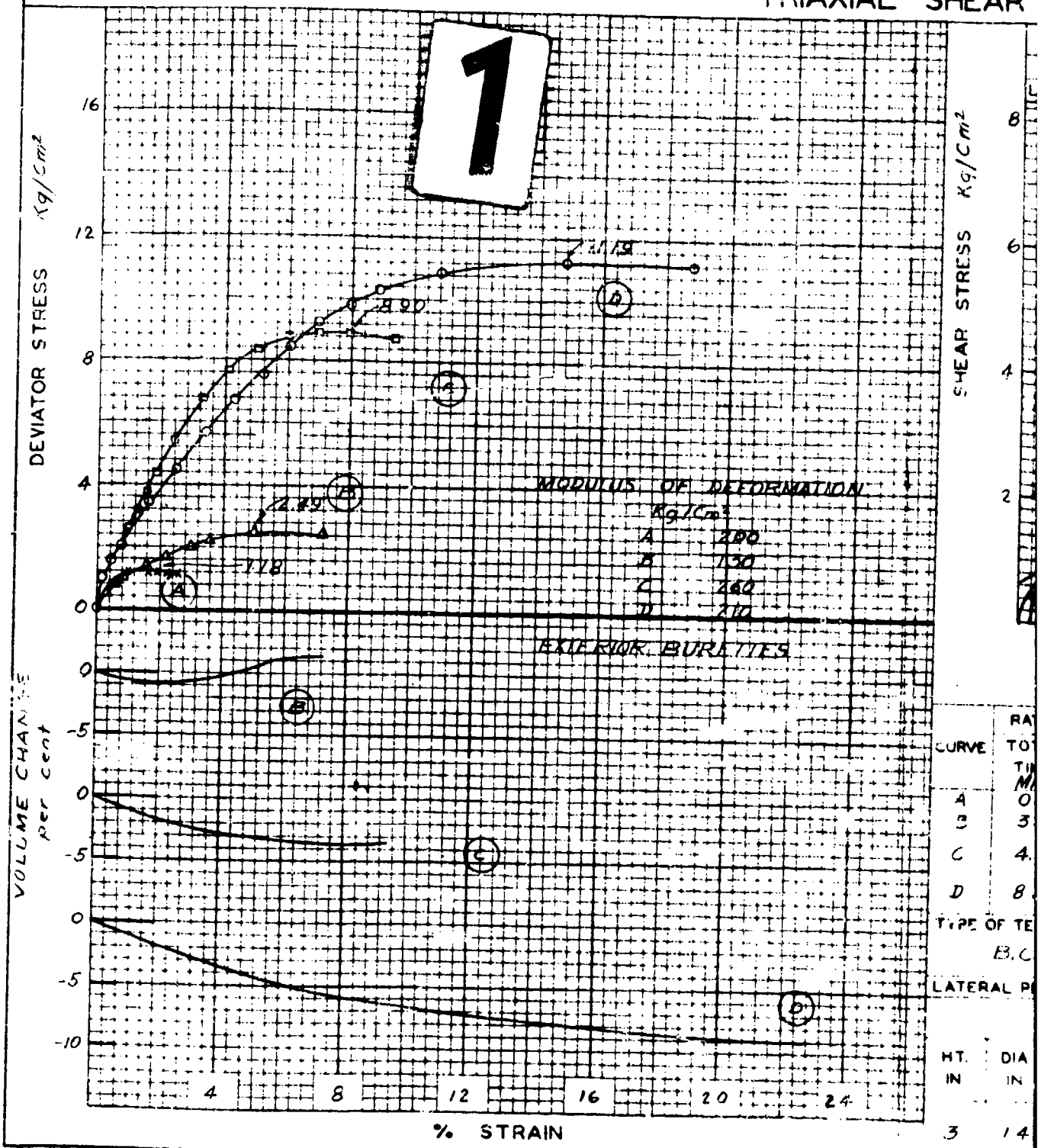
MERIDIAN	
BASIS	DL
CHECKED	H.E.R.
SUBMITTED BY	Donald F. Russell
APPROVED	James G. Lawrence, Col. CE, District Engineer; A. Patterson, Chief, Engineering Division; H. E. Wilke, Chief, Construction Division
RECOMMENDED	H. E. Wilke
DATE	21 FEB 1962
SCALE	AS SHOWN
SHEET NO	19
DRAWING NO	
FILE NO	84-01-162

CONFIDENTIAL - SECURITY INFOPMATION PLATE 2

CORPS OF ENGINEERS

SOUTH PACIFIC DIVISION

TRIAXIAL SHEAR



CURVE	RA TO TI M
A	0
B	3
C	4.
D	8

TYPE OF TE
B, C
LATERAL P

HT. IN	DIA IN
3	1 4

PSD Form 30 June 49 64 (Civil) R

CONFIDEN

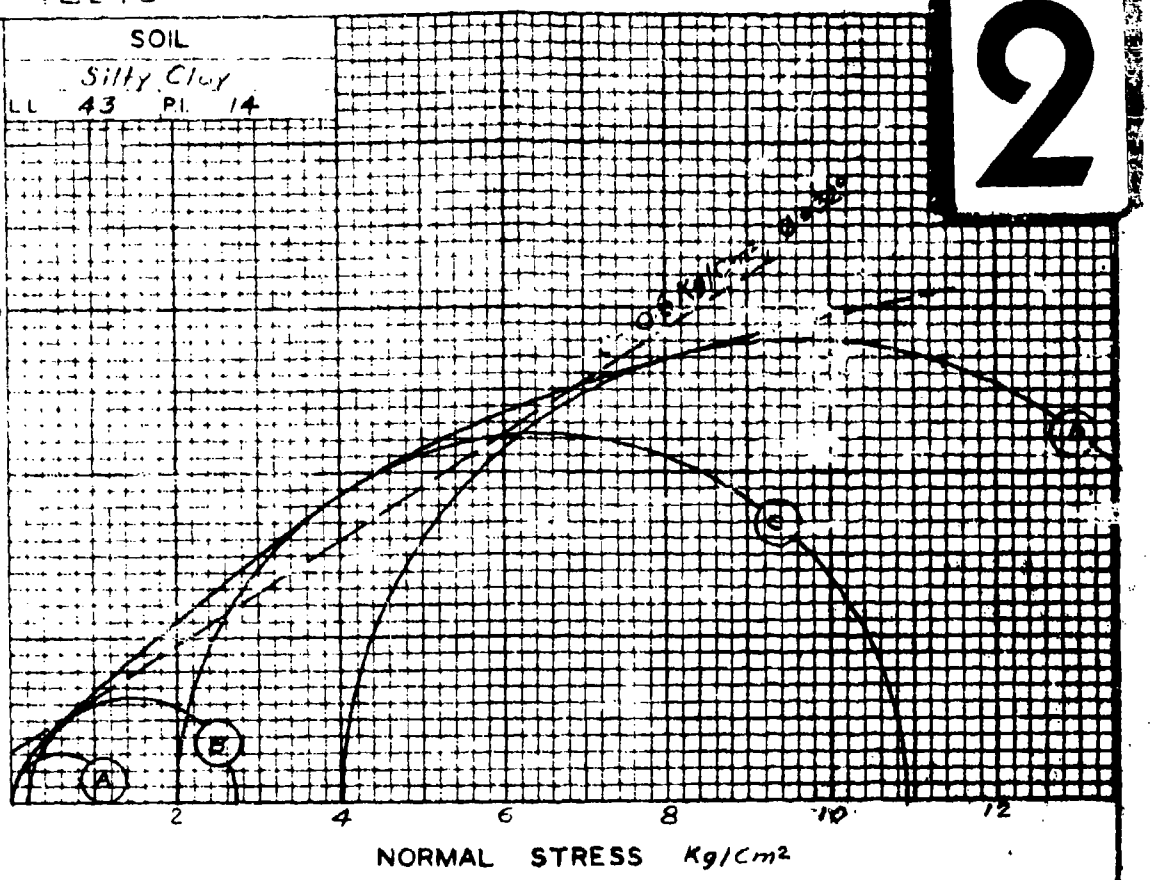
U.S. ARMY

SOUTH PACIFIC DIVISION LABORATORY — CONFIDENTIAL – SECURITY INFORMATION

TRIAXIAL SHEAR TESTS

2

SOIL: Silty Clay
LL 43 PI 14



CURVE	RATE OF SHEAR TOTAL TIME Min.	RATE OF SHEAR AVE. % PER Min.	LATERAL PRESSURE Kg/Cm²	SPECIMEN PREPARED AT DRY WEIGHT LB/CF.	SPECIMEN PREPARED AT MOISTURE %	MOISTURE %	SATURATION %	FINAL MOISTURE %
A	0.9	2	0.0	69.1	13.3	15.3	24	13.3
B	3.0	2	0.2	70.6 * 70.4	13.6	13.6	2.6	13.6
C	4.5	2	2.0	74.2 * 78.5	15.6	15.4	35	14.4
D	8.5	2	4.0	72.5 * 80.2	14.0	14.0	33	14.0

TYPE OF TEST: A Unconfined Compression
B.C.U. Consolidated-Undrained

LATERAL PRESSURE METHOD: Hydraulic

SPECIMEN DATA

HT. IN	DIA IN	MAXIMUM PARTICLE SIZE	G	CONDITION
3	1.4	No 60	2.79	Undisturbed, tested at field moisture

UNDERGROUND EXPLOSION TESTS
SUPPLEMENTARY SKEW STRUCTURES PROGRAM

DIV. NO: 270-SA
DIST. NO: E-1154BA
F.S. NO: U.S. NO. 51-26
SITE: Dry Clay
DEPTH: 4.5 - 5.8' ROUND: 5-1
* Density of Specimen after Shear

TESTED	COMPUTED	DRAWN	CHECKED
JMH	WHM	[illegible]	E.B.H.

CONFIDENTIAL – SECURITY INFORMATION

Figure 1

[redacted]

COMPRESSION TESTS

Test Cylinders - 3 X 6 Inches

Series	Date Poured	Date Crushed	No. of Cyls.	Age-Days	Unit Load Lbs/Sq. In.
		[redacted]-2 (Detonated 9-29-51)			
[redacted]-1	8-22	8-28	1	6	5177
	8-22	10-1	1	40	5494
[redacted]-2	8-24	8-29	1	5	3670
	8-24	10-1	1	38	6407
[redacted]-3	8-28	9-4	1	7	2941
	8-28	10-1	1	33	4648
[redacted]-4	8-30	9-4	1	5	3682
	8-30	9-11	1	12	4039
T-1	8-27	9-4	1	8	4484
	8-27	10-1	1	35	7428
T-2	8-29	9-4	1	6	4807
	8-29	10-1	1	33	4575
T-3	8-30	9-4	1	5	3205
	8-30	10-1	1	31	5780
		[redacted] (Detonated 10-11-51)			
[redacted]-4	8-29	9-4	1	6	2826
	8-29	10-16	1	47	4617
T-6	8-31	9-5	1	5	1803
	8-31	10-16	1	46	5743
T-7	9-1	9-7	1	6	3687
	9-1	10-16	1	45	3811
T-5	9-1	9-7	1	6	3431
	9-1	10-16	1	44	4543
T-6	9-4	9-10	1	6	4157
	9-4	10-16	1	41	5040
T-7	9-4	9-10	1	6	3343
	9-4	10-16	1	42	5234

* T : Data by Pittsburgh Testing Laboratories

SUPPLEMENTARY FIRE RESISTANCE PROGRAM

CONCRETE BEAM

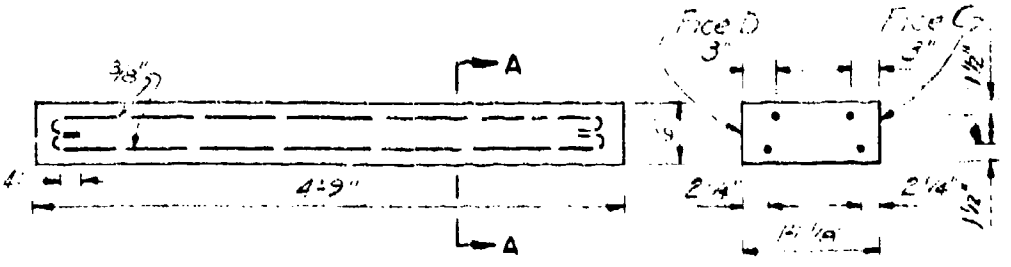
Flexural Test - Third Point Loading

Load - Pounds	Deflection Inches	Deflection Inches	Average Deflection Inches
0	0.000	0.000	0.0000
1,000	0.004	0.011	0.0075
2,000	0.008	0.017	0.0125
3,000	0.011	0.024	0.0175
4,000	0.018	0.032	0.0240
5,000	0.026	0.048	0.0370
6,000	0.047	0.073	0.0600
7,000	0.066	0.097	0.0815
8,000	0.097	0.135	0.1160
9,000	0.168	0.210	0.1890
9,750	Tension failure of concrete		
9,500	0.236	0.234	0.235
10,000	0.248	0.306	0.277
10,500	0.304	0.371	0.338
11,000	0.373	0.441	0.407
11,500	0.437	0.505	0.471
11,600	Steel broke		

N.B.: Data by Pittsburgh Testing Laboratories

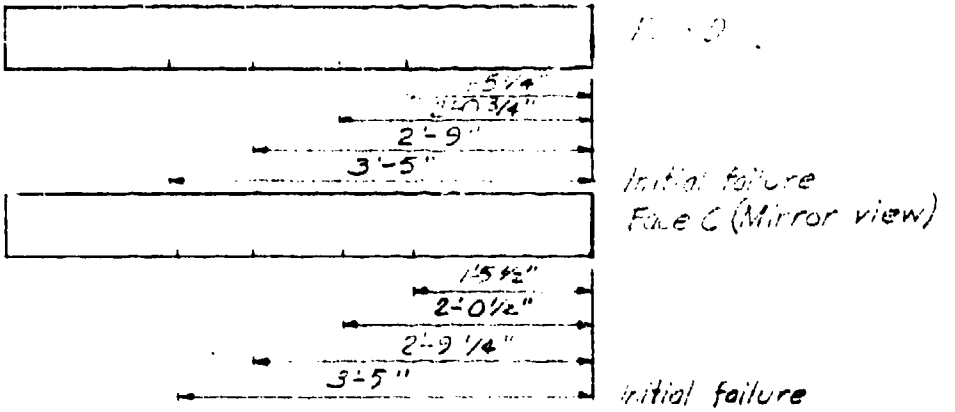
Figure 3

R

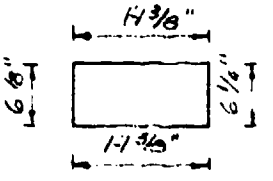


ELEVATION SECTION A-A

TEST BEAM



CRACK LOCATIONS AT ULTIMATE LOAD



SECTION AT FAILURE

$$I = \frac{bd^3}{12} = \frac{3.38(6.3)^3}{12} = 26.4\ in.^4$$

$$E = \frac{P}{24\Delta I}(3L^2 - 4L^2)$$

$$= \frac{2000(16.67)(388)}{24(.024)26.4}$$

$$= 4.2 \times 10^6\ lbs/in^2$$

$$L = 50"$$

$$a = 16.67"$$

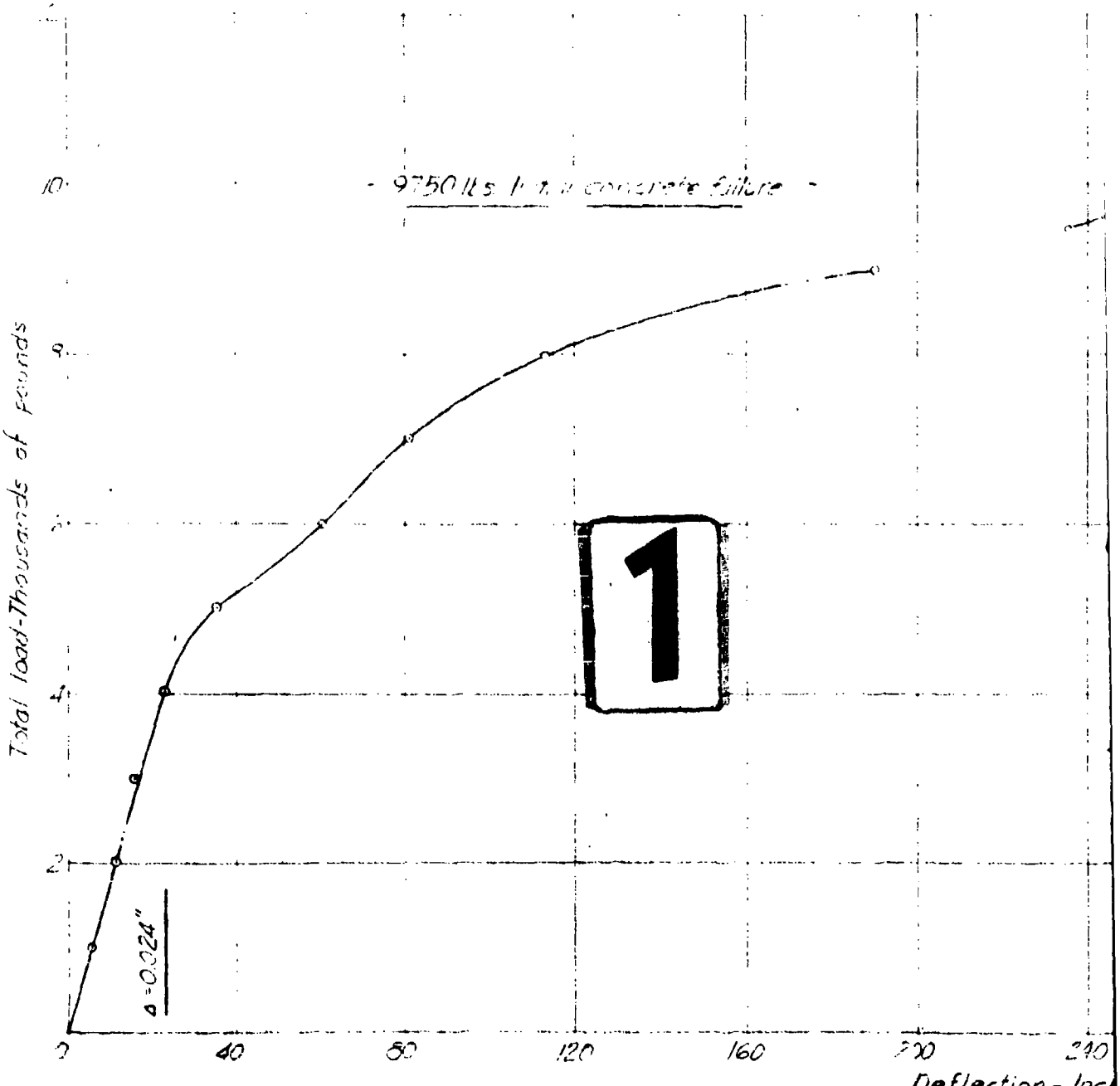
$$F = \frac{Mc}{bd^2} = \frac{16.67(50)}{13.38(6.19)^2}$$

$$= 1230\ lbs/in^2$$

SUPPLEMENTARY SKEW STRUCTURES PROGRAM

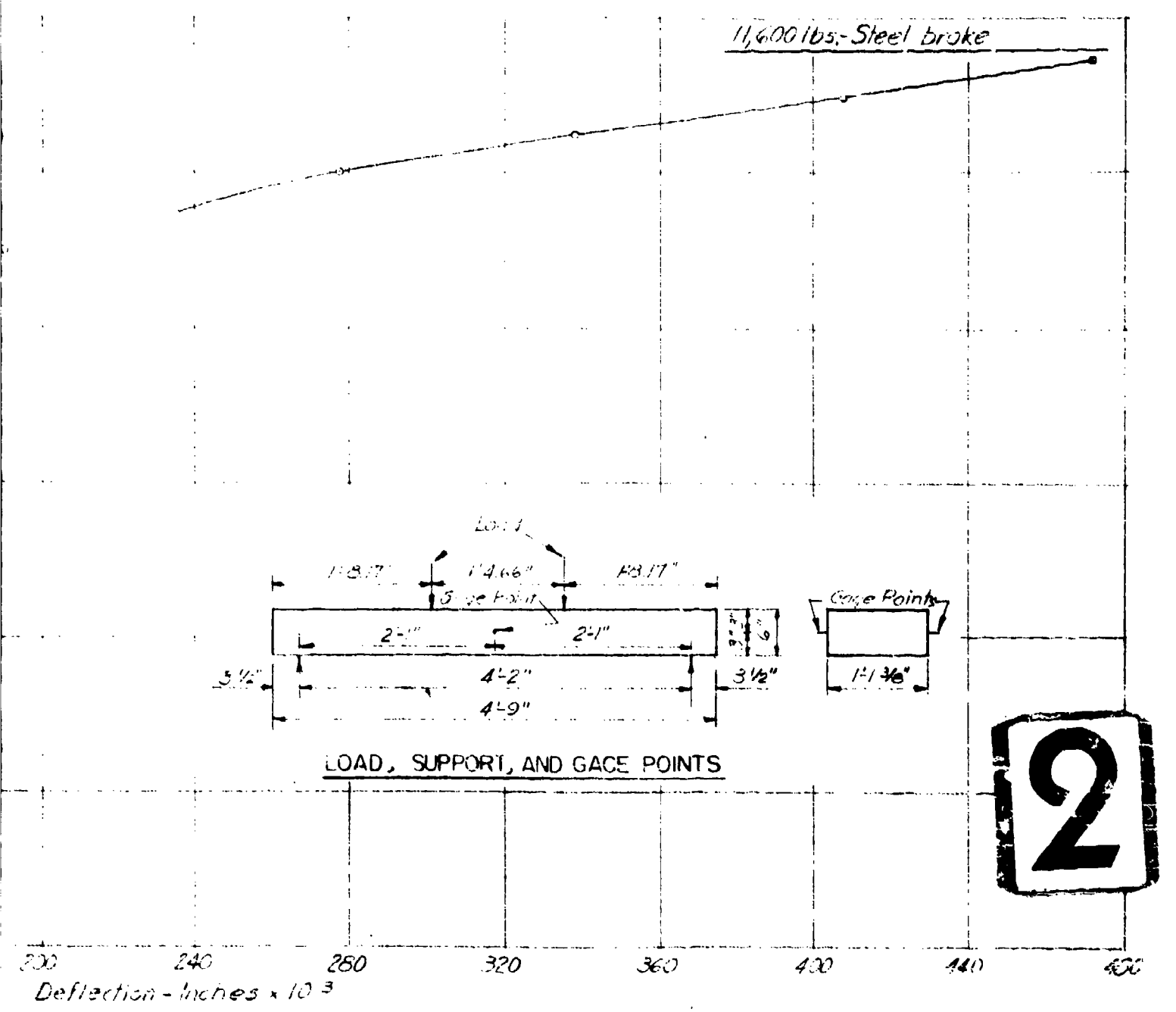
CONCRETE BEAM – FLEXURAL TEST

Figure 4



Note Beam fabricated from sample of concrete for Target, T-6, Round S-3, and is considered representative of concrete in the skew targets, Age 40 days

SUPPLEMENTARY SKEW S
CONCRETE BEAM – F



LOAD, SUPPORT, AND GACE POINTS

ENTARY SKEW STRUCTURES PROGRAM
ETE BEAM – FLEXURAL TEST

CONFIDENTIAL
Security Information

Figure 5

CONFIDENTIAL
SECURITY INFORMATION

SUPPLEMENTARY SKEW STRUCTURES PROGRAM

SUMMARY OF TENSION TESTS - STEEL REINFORCEMENT BARS

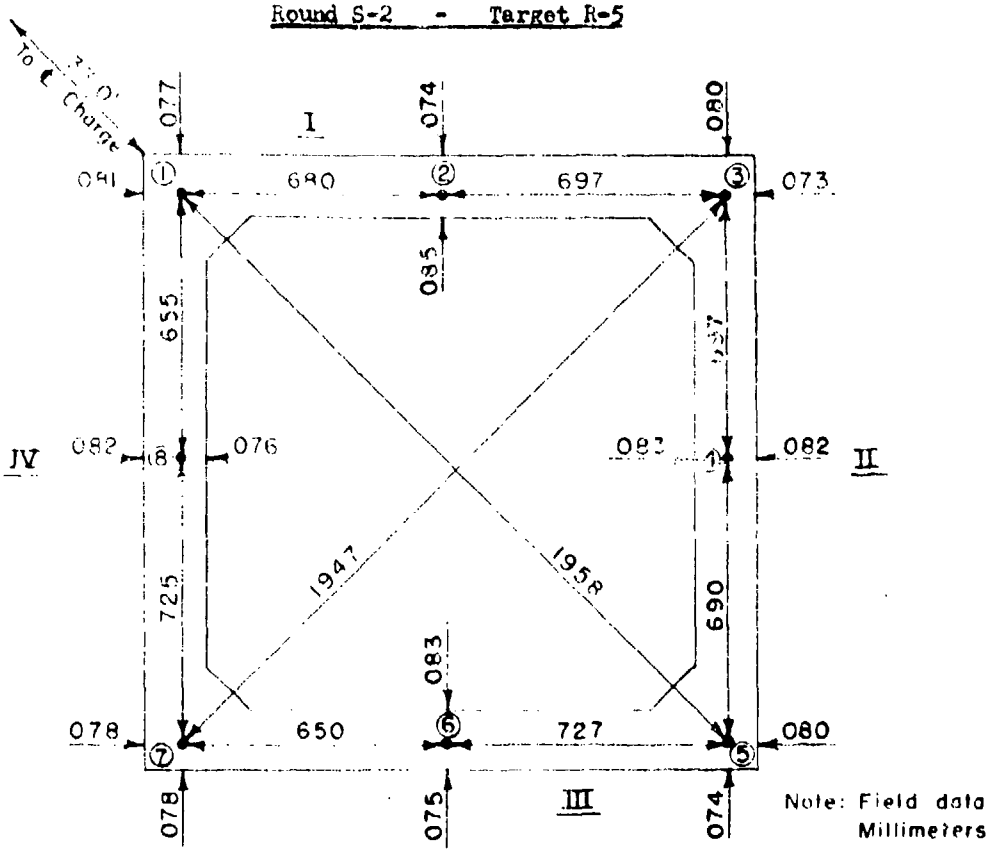
Spec. No.	Size	Yield Point p.s.i.	Ultimate Strength p.s.i.	Elongation - % 8" Gage Length
A	3/8" Rd.	49,500	60,900	19
B	3/8" Rd.	49,500	62,200	17
C	3/8" Rd.	50,500	58,800	21
	Average	49,800	60,300	19

NOTE: All bars are type deformed steel reinforcement, Intermediate Grade
Yield Point determined by Drop Beam Method (ASTM Designation A 160-3a)
Data by Pittsburgh Testing Laboratories

CONFIDENTIAL
SECURITY INFORMATION

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target R-5



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	AFTER DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	DISPLACEMENT X Meters	Y Meters	Elev. Meters
1	473.4100	507.4604	97.0898	473.4003	507.5033	97.0869	-0.0097	+0.0429	-0.0029
2	472.7817	507.8263	97.0876	472.7699	507.8649	97.0841	-0.0118	+0.0386	-0.0035
3	472.2263	508.1628	97.0884	472.2074	508.1958	97.0841	-0.0189	+0.0330	-0.0043
4	472.5923	508.7909	97.0908	472.5773	508.8235	97.0849	-0.0150	+0.0326	-0.0059
5	472.9195	509.3560	97.0897	472.9068	509.3892	97.0820	-0.0127	+0.0332	-0.0077
6	473.5117	509.0158	97.0935	473.5021	509.0539	97.0912	-0.0096	+0.0381	-0.0073
7	474.1076	508.6582	97.0955	474.0993	508.7012	97.0892	-0.0083	+0.0430	-0.0063
8	473.7604	508.0548	97.0905	473.7494	508.0979	97.0862	-0.0110	+0.0431	-0.0043

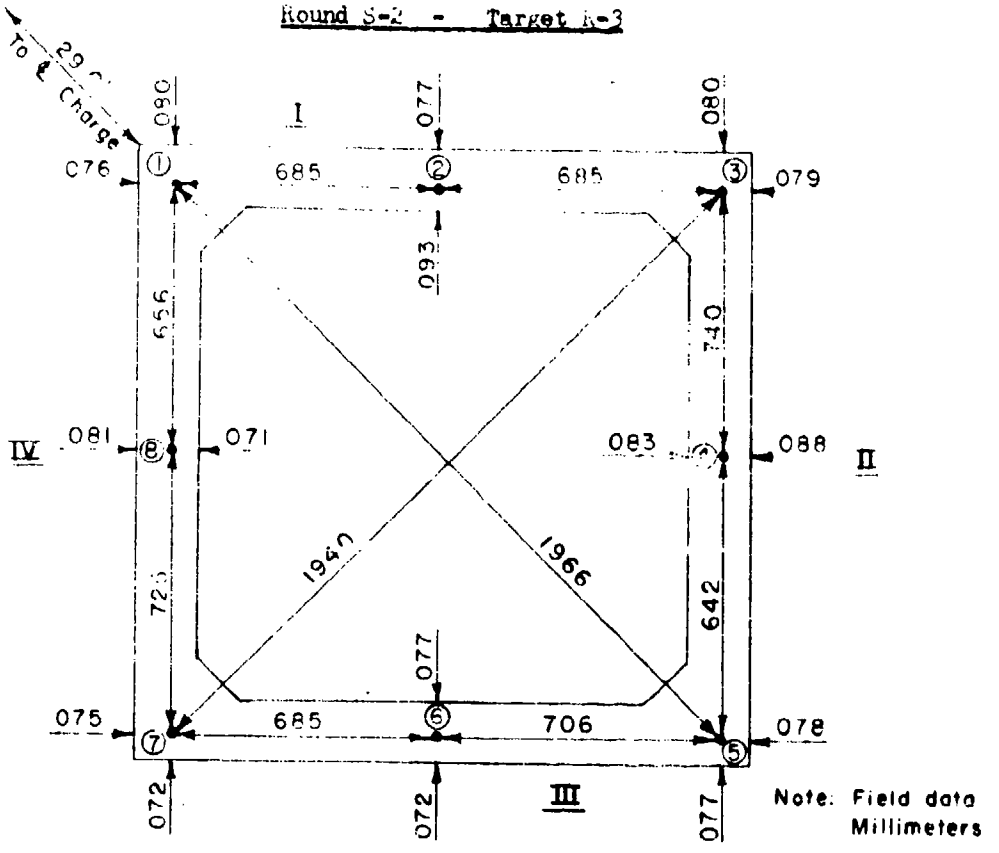
Center of Charge X = 475.0809 Y = 497.6579

CONFIDENTIAL
SECURITY INFORMATION

FIGURE 7

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target A-3



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

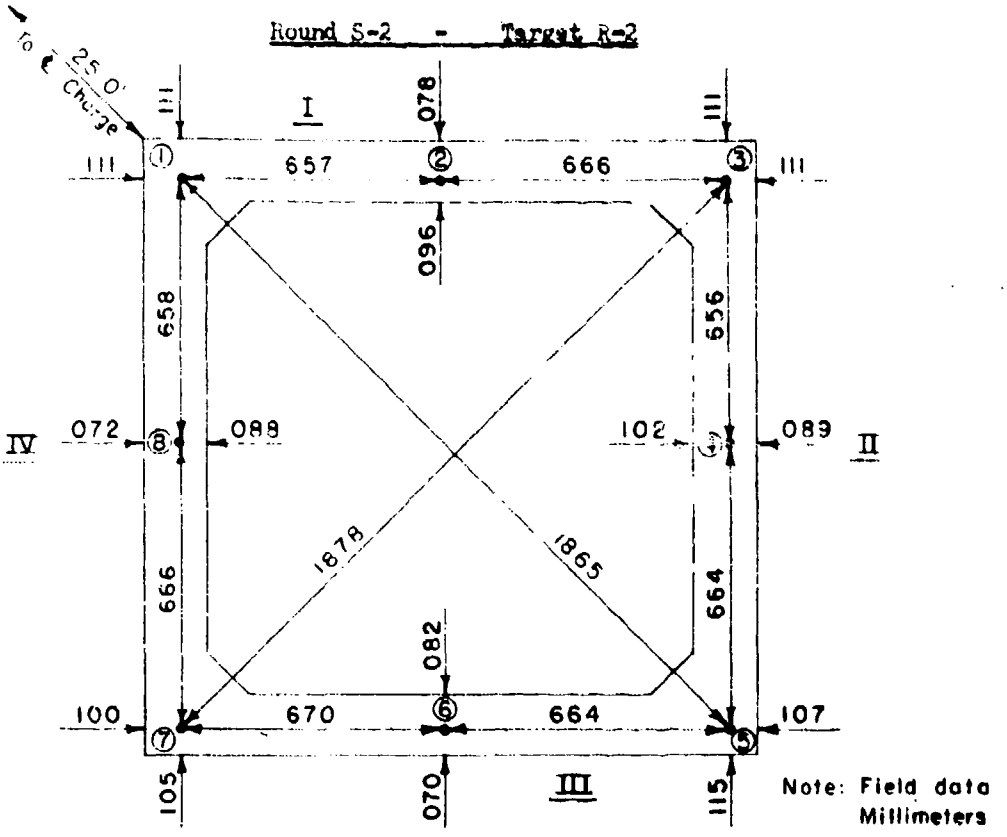
Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	479.1262	506.0791	97.1000	479.1429	506.1279	97.1020	+0.0167	+0.0488	+0.0020
2	478.8340	506.6989	97.0966	478.8460	506.7461	97.0992	+0.0120	+0.0472	+0.0026
3	478.5524	507.3214	97.0955	478.5579	507.3686	97.0990	+0.0055	+0.0472	+0.0035
4	479.2262	507.6354	97.0931	479.2348	507.6743	97.0950	+0.0086	+0.0389	+0.0019
5	479.7962	507.9284	97.0964	479.8086	507.9633	97.0971	+0.0124	+0.0349	+0.0007
6	480.0932	507.2860	97.0971	480.1092	507.3220	97.0976	+0.0160	+0.0360	+0.0005
7	480.3706	506.6629	97.1040	480.3993	506.6996	97.1044	+0.0287	+0.0367	+0.0004
8	479.7207	506.3570	97.1021	479.7402	506.4016	97.1033	+0.0195	+0.0446	+0.0012

Center of Charge X = 476.0809 Y = 497.6579

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target R-2



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	BEFORE DETONATION Y Coord. Meters	BEFORE DETONATION Elev. Meters	AFTER DETONATION X Coord. Meters	AFTER DETONATION Y Coord. Meters	AFTER DETONATION Elev. Meters	DISPLACEMENT X Meters	DISPLACEMENT Y Meters	DISPLACEMENT Elev. Meters
1	482.4277	502.1252	97.0837	482.4579	502.1172	97.0878	+0.0302	-0.0080	+0.0041
2	482.5061	502.7786	97.0942	482.5126	502.7726	97.1008	+0.0065	-0.0060	+0.0066
3	482.6591	503.4268	97.1049	482.6499	503.4266	97.1144	-0.0092	-0.0002	+0.0095
4	483.3114	503.3462	97.1054	483.3026	503.3361	97.1144	-0.0088	-0.0101	+0.0090
5	483.9567	503.1945	97.1026	483.9464	503.1737	97.1134	-0.0103	-0.0208	+0.0108
6	483.8853	502.5333	97.0897	483.8962	502.5157	97.0944	+0.0109	-0.0176	+0.0047
7	483.7258	501.8806	97.0827	483.7578	501.8566	97.0848	+0.0320	-0.0240	+0.0021
8	483.0651	501.9606	97.0791	483.0987	501.9501	97.0822	+0.0336	-0.0105	+0.0031

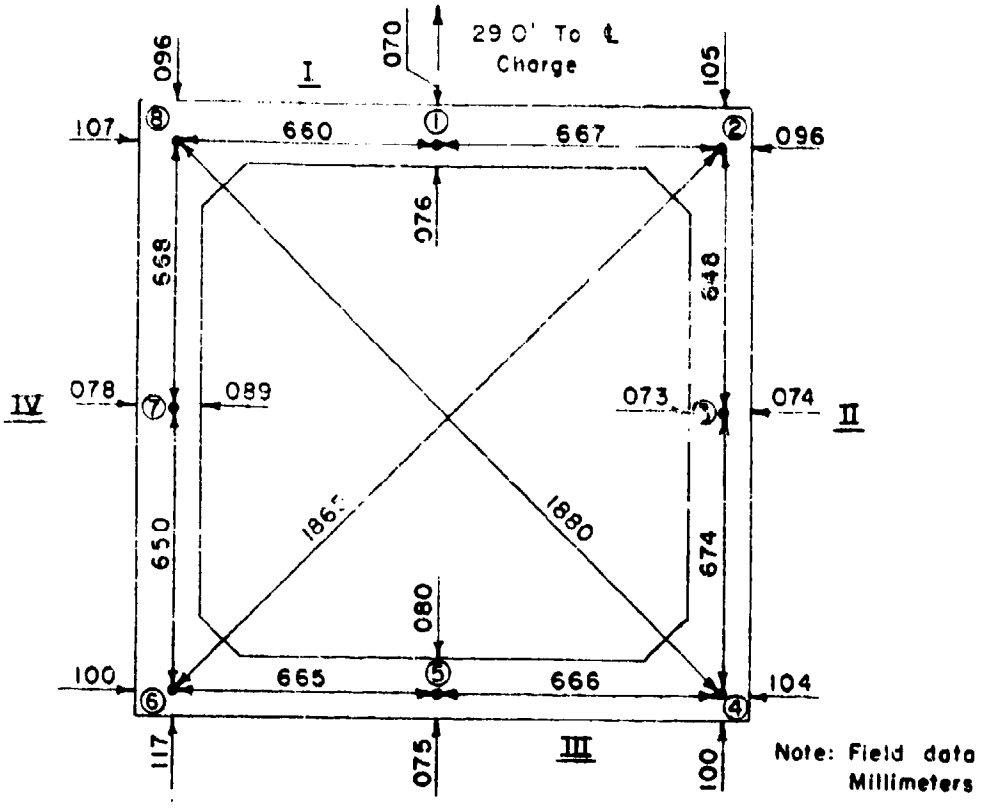
Center of Charge X = 476.0809 Y = 497.6579

CONFIDENTIAL
SECURITY INFORMATION

FIGURE 9

SUPPLEMENTAL U.S. STRATEGIC PROGRAM

Round 3-2 - Target A-1



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	BEFORE DETONATION Y Coord. Meters	BEFORE DETONATION Elev. Meters	AFTER DETONATION X Coord. Meters	AFTER DETONATION Y Coord. Meters	AFTER DETONATION Elev. Meters	DISPLACEMENT X Meters	DISPLACEMENT Y Meters	DISPLACEMENT Elev. Meters
1	485.0620	497.6768	97.0908	485.0606	497.6655	97.0883	+0.0586	-0.0113	-0.0025
2	485.0279	498.3438	97.0883	485.0805	498.3330	97.0842	+0.0526	-0.0108	+0.0040
3	485.0704	498.3753	97.0837	485.7281	498.3659	97.0818	+0.0577	-0.0094	+0.0011
4	484.9801	498.3555	97.0805	484.4076	498.3462	97.0813	+0.0522	-0.0088	+0.0008
5	484.9510	497.7004	97.0891	484.4314	497.6807	97.0867	+0.0514	-0.0097	-0.0024
6	484.9420	497.0246	97.0901	484.4024	497.0154	97.0852	+0.0556	-0.0092	-0.0049
7	484.9720	497.0940	97.0913	485.2537	497.0816	97.0857	+0.0567	-0.0124	-0.0056
8	485.0277	497.7166	97.0940	485.0837	497.0045	97.0883	+0.0560	-0.0121	-0.0057

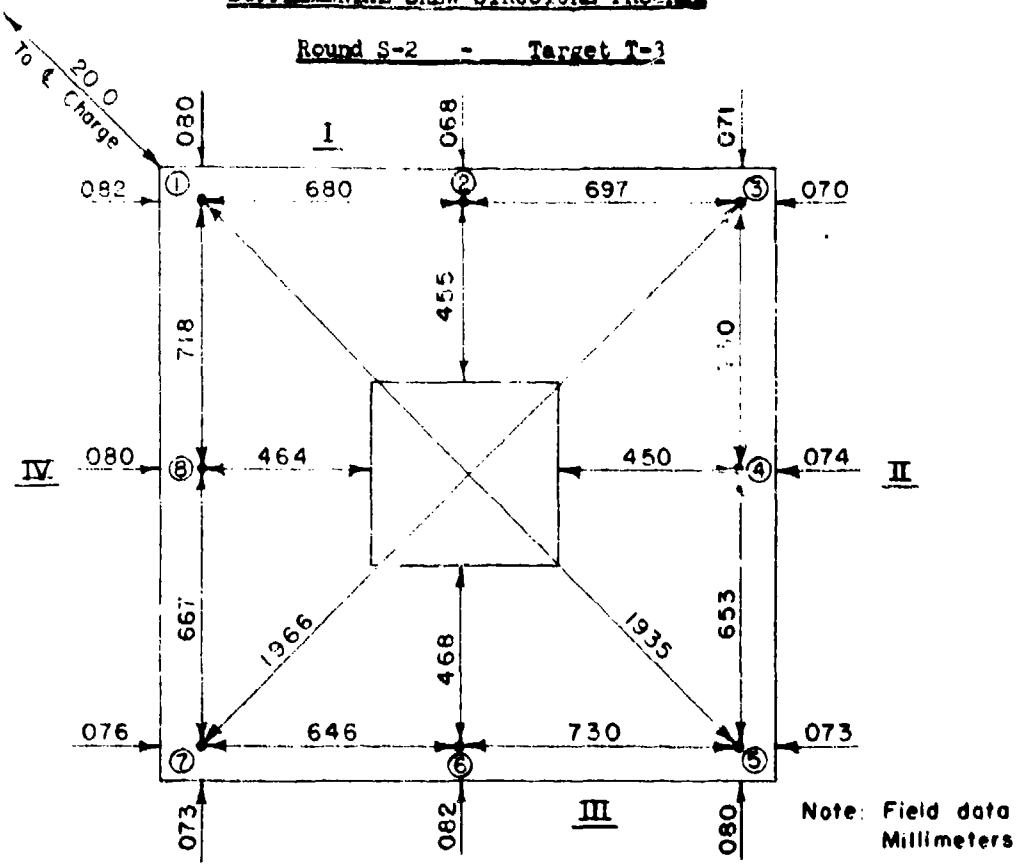
Center of Charge X = 485.0509 Y = 497.6579

CONFIDENTIAL
SECURITY INFORMATION

FIGURE 10

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target T-3



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

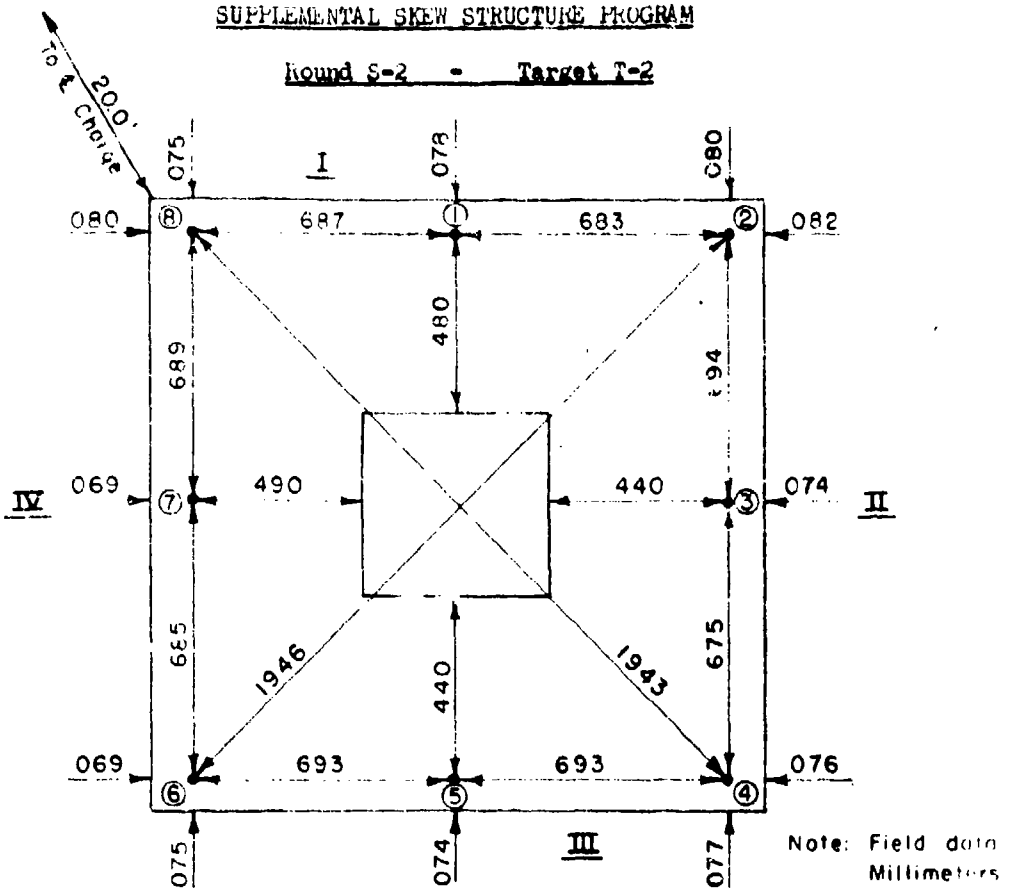
Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	481.1724	494.1234	97.0832	481.2903	494.0427	97.2557	+0.1179	-0.0807	+0.1725
2	481.8396	494.2528	97.0860	481.9560	494.1757	97.2048	+0.1164	-0.0771	+0.1188
3	482.5246	494.3733	97.0830	482.6404	494.3003	97.1453	+0.1158	-0.0730	+0.0623
4	482.6454	493.6544	97.0908	482.7597	493.5811	97.1074	+0.1143	-0.0733	+0.0166
5	482.7571	493.0101	97.0942	482.8701	492.9385	97.0694	+0.1130	-0.0716	-0.0248
6	482.0357	492.8832	97.0912	482.1531	492.8079	97.1248	+0.1174	-0.0753	+0.0336
7	481.4039	492.7581	97.0860	481.5210	492.6796	97.1705	+0.1171	-0.0785	+0.0845
8	481.2915	493.4151	97.0838	481.4111	493.3368	97.2110	+0.1196	-0.0783	+0.1272

Center of Charge X = 476.0809 Y = 497.6579

FIGURE 11

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target T-2



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

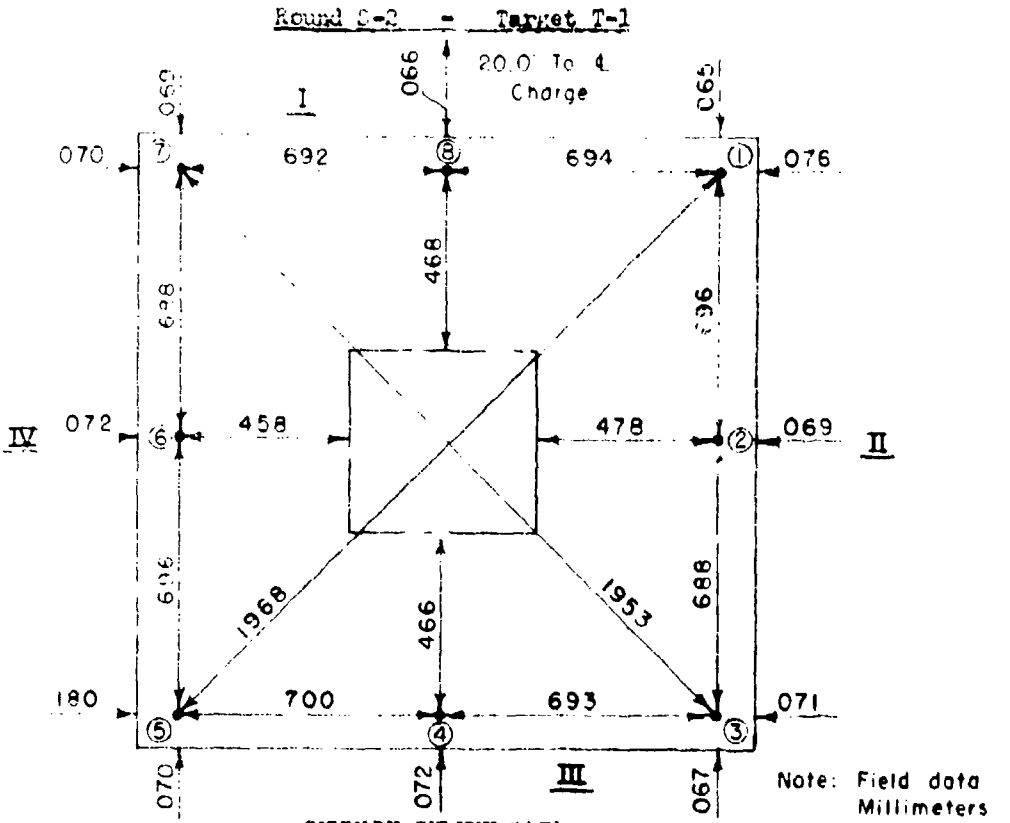
Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	478.9187	491.7362	97.0984	479.0069	491.6340	97.2413	+0.0882	-0.1022	+0.1429
2	479.5907	491.6204	97.1094	479.6765	491.5054	97.2053	+0.0858	-0.1150	+0.0959
3	479.4830	490.9357	97.0998	479.5499	490.8263	97.1362	+0.0669	-0.1094	+0.0364
4	479.3706	490.2702	97.0939	479.4202	490.1661	97.0727	+0.0496	-0.1041	-0.0212
5	478.6862	490.3778	97.0922	478.7393	490.2876	97.1172	+0.0531	-0.0902	+0.0250
6	478.0038	490.4943	97.0876	478.0590	490.4155	97.1597	+0.0552	-0.0788	+0.0721
7	478.1156	491.1707	97.0865	478.1890	491.0862	97.2174	+0.0734	-0.0845	+0.1309
8	478.2385	491.8489	97.0883	478.3305	491.7610	97.2776	+0.0920	-0.0879	+0.1893

Center of Charge X = 478.0809 Y = 497.6579

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-2 - Target T-1



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

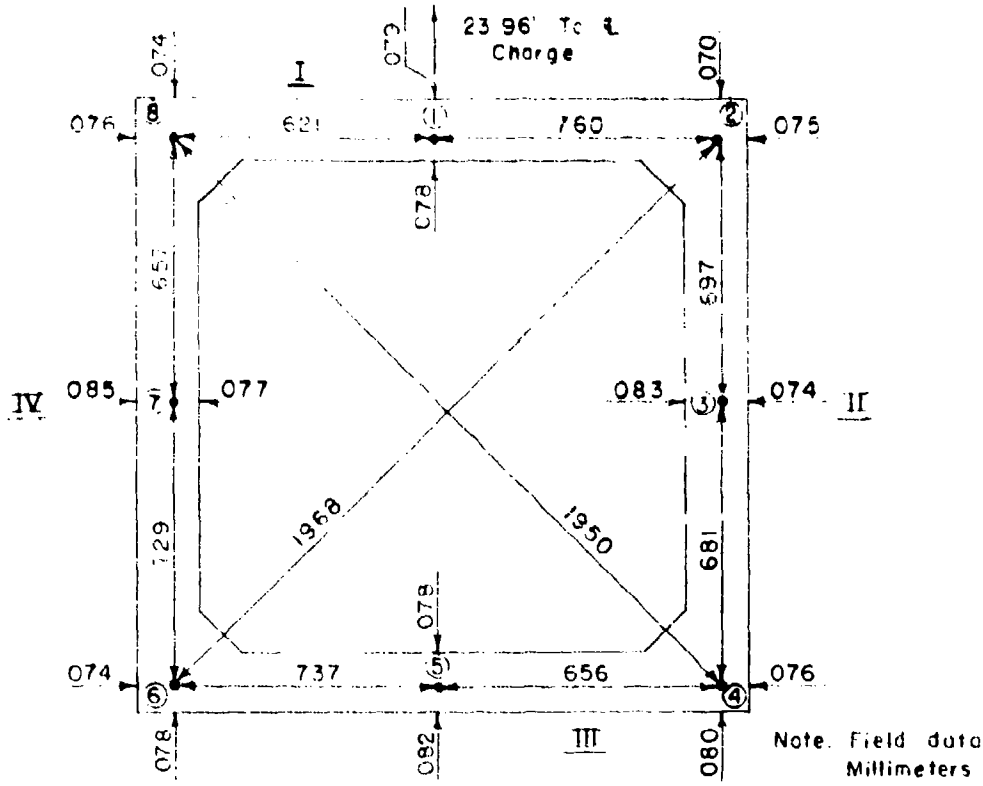
Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	475.1655	491.5091	97.0963	475.2182	491.3657	97.2314	+0.0527	-0.1434	+0.1351
2	474.9880	490.8362	97.0986	475.0201	490.7019	97.1656	+0.0321	-0.1343	+0.0670
3	474.8078	490.1732	97.0957	474.8180	490.0467	97.0972	+0.0102	-0.1265	+0.0015
4	474.1370	490.3449	97.0977	474.1525	490.2382	97.1136	+0.0155	-0.1067	+0.0159
5	473.4619	490.5284	97.0954	473.4830	490.4399	97.1271	+0.0211	-0.0885	+0.0317
6	473.6460	491.1994	97.0989	473.6847	491.1028	97.1958	+0.0387	-0.0966	+0.0969
7	473.8280	491.8631	97.0995	473.8843	491.7585	97.2616	+0.0563	-0.1046	+0.1621
8	474.4979	491.6882	97.0991	474.5513	491.5630	97.2560	+0.0534	-0.1252	+0.1569

Center of Charge X = 476.0809 Y = 497.6579

SUPPLEMENTAL SHOCK STRUCTURE PROGRAM

Round [illegible] - Target No. 4



SUMMARY SURVEY DATA

Station "C" - X-500 & Y-500
Azimuth "A" - 0° - 00' - 00"
- Y Ordinate

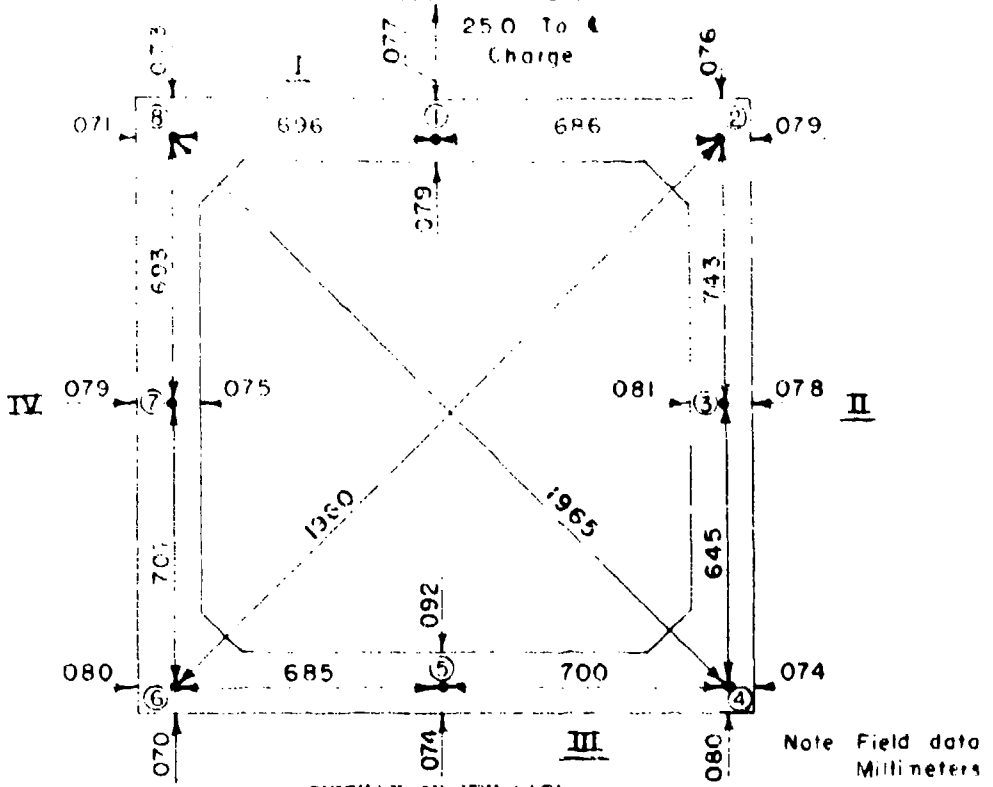
Data supplied by U. S.
Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	AFTER DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	DISPLACEMENT X Meters	Y Meters	Elev. Meters
1	477.7766	503.5273	97.6241	477.8082	503.7532	97.6523	+0.0316	+0.2261	+0.0282
2	477.0276	503.6495	97.6241	477.0503	503.8598	97.6506	+0.0227	+0.2103	+0.0255
3	477.1439	504.3368	97.6261	477.1581	504.5492	97.6506	+0.0142	+0.2124	+0.0245
4	477.2620	505.0104	97.6354	477.2814	505.2220	97.6586	+0.0194	+0.2116	+0.0232
5	477.9074	504.9015	97.6331	477.9270	505.0979	97.6596	+0.0196	+0.1964	+0.0265
6	478.6369	504.7838	97.6354	478.6607	505.0001	97.6636	+0.0238	+0.2163	+0.0282
7	478.4976	504.0669	97.6311	478.5306	504.2812	97.6609	+0.0330	+0.2143	+0.0298
8	478.3913	503.4189	97.6238	478.4184	503.6311	97.6548	+0.0271	+0.2122	+0.0310

Center of Charge X = 478.3817 Y = 495.9499

SUPPLEMENTAL OPERATIONAL PROGRAM

Round 2-2 - Target A-6



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

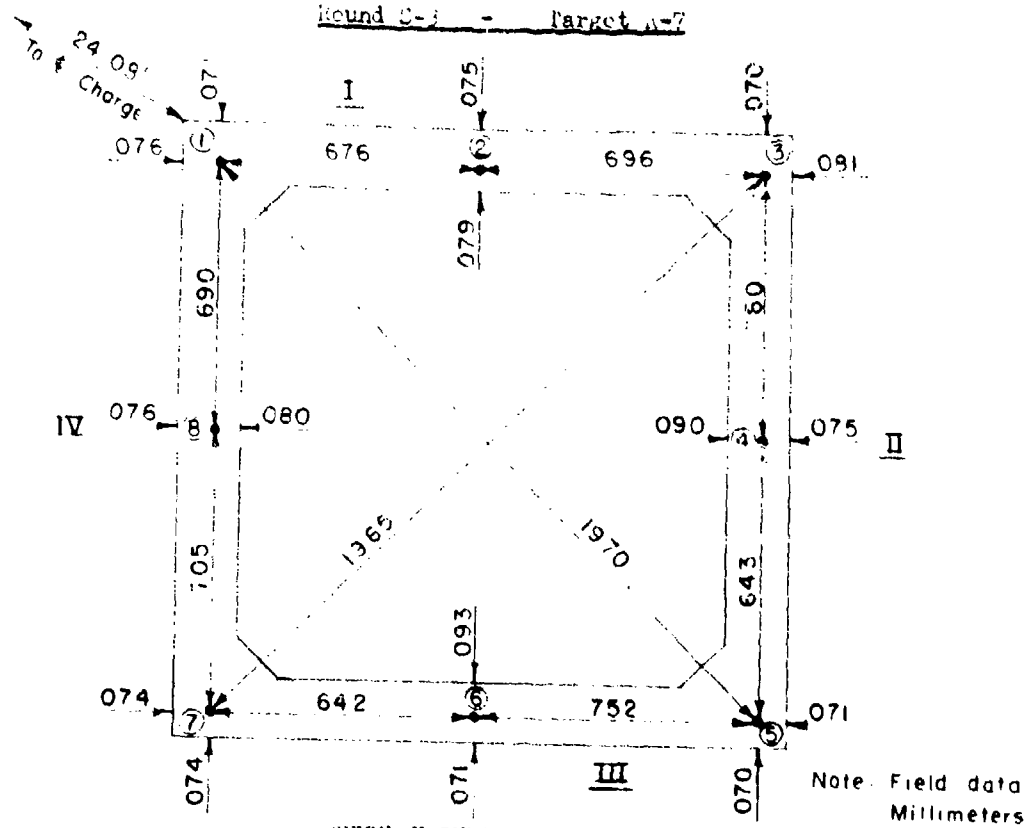
Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	AFTER DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	DISPLACEMENT X Meters	Y Meters	Elev. Meters
1	484.0712	495.9713	97.6144	484.1987	495.9902	97.6496	+0.1275	+0.0189	+0.0352
2	484.0653	496.6564	97.6091	484.1716	496.6784	97.6439	+0.1063	+0.0220	+0.0348
3	484.8061	496.6659	97.6134	484.9152	496.6938	97.6386	+0.1091	+0.0279	+0.0252
4	485.4531	496.6748	97.6188	485.5619	496.6975	97.6349	+0.1088	+0.0227	+0.0161
5	485.4669	495.9743	97.6218	485.5646	495.9955	97.6396	+0.0977	+0.0212	+0.0178
6	485.4084	495.2899	97.6351	485.5743	495.3099	97.6546	+0.1659	+0.0200	+0.0195
7	484.7668	495.2827	97.6298	484.8732	495.2953	97.6566	+0.1064	+0.0126	+0.0268
8	484.0736	495.2738	97.6251	484.1768	495.2922	97.6629	+0.1032	+0.0184	+0.0378

Center of Charge X = 470.3817 Y = 495.9499

SUPPLEMENTAL CROSS STRUCTURE PROGRAM

Round C-1 - Target A-7



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

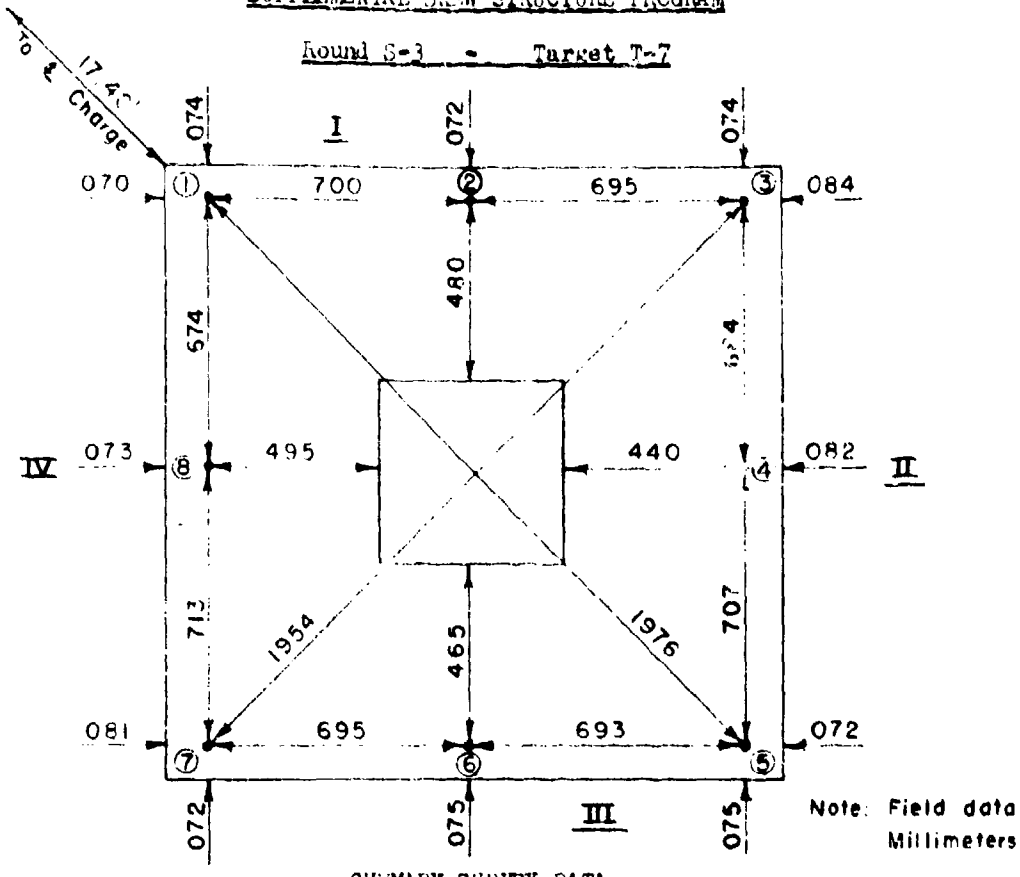
Data supplied by U. S.
Coast & Geodetic Survey

Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	482.0792	500.7538	97.6221	482.2323	500.8669	97.6706	+0.1531	+0.1131	+0.0485
2	482.3152	501.3875	97.6128	482.4196	501.5175	97.6536	+0.1044	+0.1300	+0.0408
3	482.5500	502.0420	97.6081	482.6324	502.1878	97.6409	+0.0824	+0.1458	+0.0328
4	483.2674	501.7899	97.6174	483.3293	501.8856	97.6446	+0.0619	+0.0957	+0.0272
5	483.8720	501.5684	97.6204	483.9344	501.6555	97.6416	+0.0624	+0.0871	+0.0212
6	483.6152	500.8632	97.6231	Destroyed by Explosion					
7	483.3856	500.2640	97.6334	483.5356	500.3466	97.6706	+0.1500	+0.0826	+0.0372
8	482.7243	500.5087	97.6254	482.8899	500.6344	97.6676	+0.1656	+0.1257	+0.0422

Center of Charge X = 476.3817 Y = 495.9499

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-3 - Target T-7



SUMMARY SURVEY DATA

Station "C" - X=500 & Y=500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

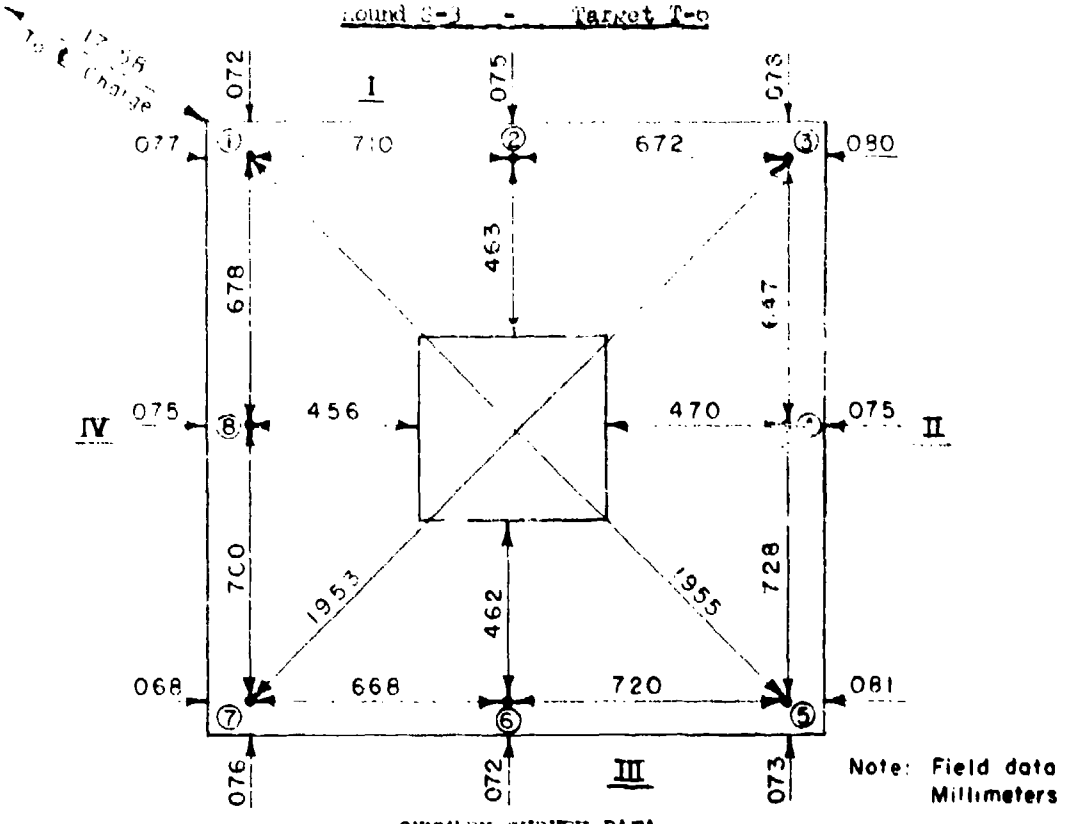
Point	BEFORE DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	AFTER DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	DISPLACEMENT X Meters	Y Meters	Elev. Meters
1	480.5261	492.4586	97.6364	480.7784	492.3033	97.7803	+0.2523	-0.1693	+0.1439
2	481.2215	492.5258	97.6371	481.4737	492.3650	97.7483	+0.2522	-0.1608	+0.1112
3	481.9139	492.5814	97.6388	482.1664	492.4280	97.7158	+0.2525	-0.1534	+0.0770
4	481.9796	491.9005	97.6388	482.2367	491.7445	97.6996	+0.2571	-0.1560	+0.0608
5	482.0473	491.1968	97.6371	482.2841	491.0398	97.6816	+0.2368	-0.1570	+0.0445
6	481.3592	491.1326	97.6331	Destroyed by explosion					
7	480.6648	491.0792	97.6328	480.9037	490.9076	97.7329	+0.2389	-0.1716	+0.1001
8	480.5904	491.7876	97.6318	480.8364	491.6176	97.7549	+0.2460	-0.1700	+0.1231

Center of Charge X = 476.3817 Y = 495.9499

FIGURE 17

SUPPLEMENTAL SOIL STRUCTURE PROGRAM

Round S-1 - Target T-6



SUMMARY SURVEY DATA

Station "C" - X-500 & Y-500
Azimuth "A" - 0° - 00' - 00"
= Y Ordinate

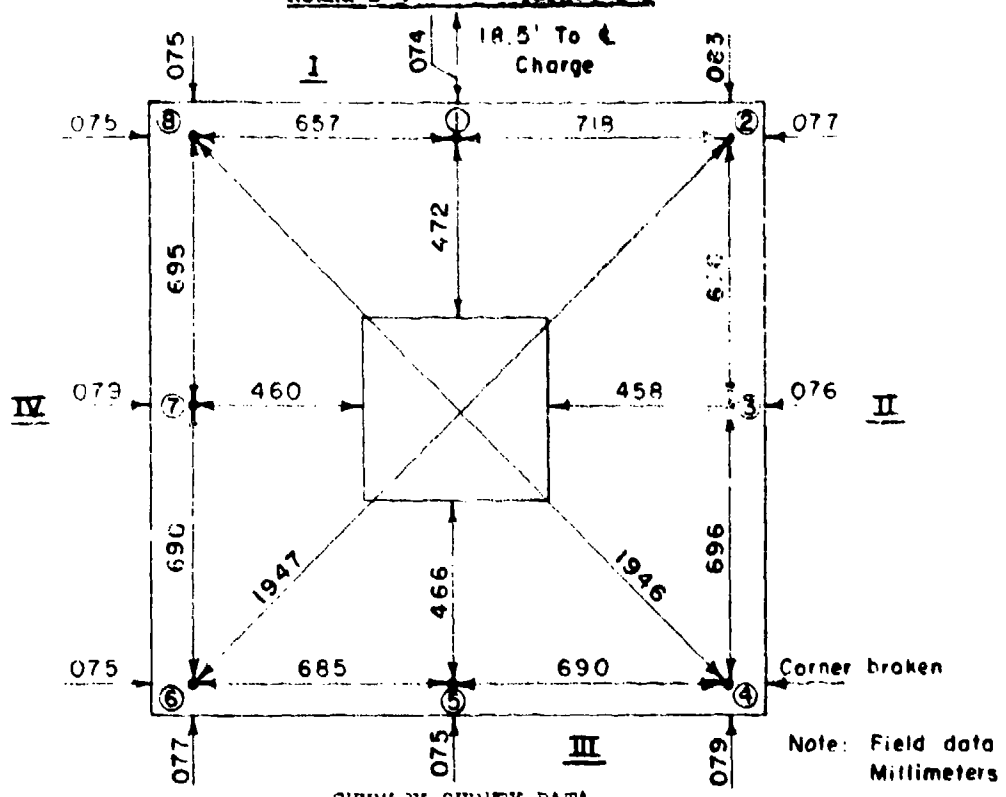
Data supplied by U. S.
Coast & Geodetic Survey

Point	BEFORE DETONATION			AFTER DETONATION			DISPLACEMENT		
	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Coord. Meters	Y Coord. Meters	Elev. Meters	X Meters	Y Meters	Elev. Meters
1	477.3265	490.3610	97.6301	477.3129	490.3953	97.7646	-0.0126	-0.2657	+0.1285
2	477.7814	490.0164	97.6388	477.8035	489.7772	97.7486	+0.0221	-0.2392	+0.1098
3	478.2097	489.4976	97.6398	478.2376	489.2638	97.7293	+0.0279	-0.2338	+0.0895
4	477.7158	489.0773	97.6421	477.7474	488.8389	97.7126	+0.0316	-0.2384	+0.0705
5	477.1531	488.6150	97.6374	477.1887	488.3686	97.6846	+0.0356	-0.2464	+0.0472
6	476.6876	489.1645	97.6431	476.7053	488.9007	97.7036	+0.0157	-0.2638	+0.0605
7	476.2654	489.6801	97.6431	476.2585	489.4002	97.7196	-0.0069	-0.2799	+0.0765
8	476.7274	490.1428	97.6401	476.8043	489.8443	97.7516	-0.0011	-0.2815	+0.1115

Center of Charge X = 476.3817 Y = 495.9499

SUPPLEMENTAL SKEW STRUCTURE PROGRAM

Round S-3 - Target T-5



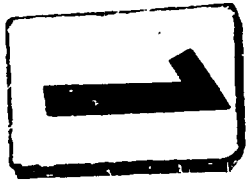
SUMMARY SURVEY DATA

Station "C" = X=500 & Y=500
Azimuth "A" = 0° - 00' - 00"
= Y Ordinate

Data supplied by U. S. Coast & Geodetic Survey

Point	BEFORE DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	AFTER DETONATION X Coord. Meters	Y Coord. Meters	Elev. Meters	DISPLACEMENT X Meters	Y Meters	Elev. Meters
1	473.5182	491.0035	97.6341	473.3401	490.[illegible]	97.[illegible]	-0.1781	-0.2666	+0.1272
2	474.1390	490.6408	97.6321	473.9735	490.3821	97.7313	-0.1655	-0.2587	+0.0992
3	473.8062	490.0519	97.6321	473.6399	489.7928	97.7066	-0.1663	-0.2591	+0.0745
4	473.4584	489.4460	97.6314	473.2934	489.1899	97.6839	-0.1650	-0.2561	+0.0525
5	472.8576	489.7837	97.6314	472.6895	489.5241	97.6876	-0.1681	-0.2596	+0.0562
6	472.2614	490.1204	97.6311	472.0877	489.8599	97.6866	-0.1737	-0.2605	+0.0555
7	472.6050	490.7200	97.6338	472.4266	490.4606	97.7126	-0.1784	-0.2594	+0.0788
8	472.9478	491.3255	97.6391	Destroyed by explosion					

Center of Charge X = 476.3817 Y = 495.9499



SUPPLEMENTARY SKEW STRUCTURES PROGRAM

TARGET MOVEMENTS

RELATIVE TO CENTER LINE OF CHARGE

ROUND S-2

Structure	Type	Radius Feet	Radius Scale λ	Skew Angle Degrees	Rivet No.	Movements - Feet Radial + = Out	Tang. + = CW	Vert. + = Up
R-5	Open Box	33	2.42	45	1	+ 0.144	+ 0.007	- 0.010
					2	+ 0.132	+ 0.002	- .011
					3	+ 0.123	- 0.021	- .014
					4	+ 0.117	- .015	- .019
					5	+ 0.116	- 0.012	- .025
					6	+ 0.129	- 0.032	- .024
					7	+ 0.144	- 0.001	- .021
					8	+ 0.146	- 0.005	- .014
R-3	Open Box	29	2.12	45	1	+ 0.169	- 0.003	+ 0.007
					2	+ 0.160	- 0.008	- .009
					3	+ 0.155	- 0.021	- .011
					4	+ 0.130	- 0.011	+ .006
					5	+ 0.121	- 0.001	+ 0.002
					6	+ 0.129	+ 0.003	+ 0.002
					7	+ 0.141	+ 0.017	+ 0.001
					8	+ 0.160	+ 0.003	- 0.004
R-2	Open Box	25	1.83	45	1	+ 0.046	+ 0.079	+ 0.013
					2	+ 0.0[illegible]	+ 0.029	+ 0.022
					3	- 0.023	- 0.019	+ 0.031
					4	- 0.043	+ 0.008	+ 0.030
					5	- 0.067	+ 0.036	+ 0.035
					6	- 0.000	+ 0.068	+ 0.015
					7	+ 0.054	+ 0.120	+ 0.007
					8	+ 0.076	+ 0.087	+ 0.010
R-1	Open Box	29	2.12	Zero	1	+ 0.192	+ 0.037	- 0.008
					2	+ 0.170	+ 0.049	+ 0.003
					3	+ 0.167	+ 0.044	+ 0.004
					4	+ 0.169	+ 0.040	+ 0.003
					5	+ 0.168	+ 0.037	- 0.008
					6	+ 0.184	+ 0.019	- 0.016

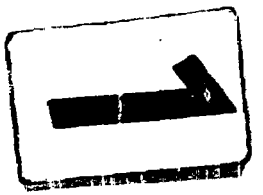
R-3	Open Box	29	2.12	45	1	+ 0.[illegible]	- 0.008	+ .009
					2	+ 0.[illegible]60	- 0.008	+ .009
					3	+ 0.155	- 0.021	+ .011
					4	+ 0.130	- 0.011	+ .006
					5	+ 0.121	- 0.001	+ 0.002
					6	+ 0.129	+ 0.003	+ 0.002
					7	+ 0.111	+ 0.017	+ .001
					8	+ 0.160	+ 0.003	- 0.004
R-2	Open Box	29	1.83	45	1	+ 0.066	+ 0.079	+ 0.013
					2	+ 0.004	+ 0.029	+ 0.032
					3	- 0.023	- 0.019	+ 0.031
					4	- 0.043	+ 0.008	+ 0.030
					5	- 0.047	+ 0.036	+ 0.035
					6	- 0.000	+ 0.008	+ 0.015
					7	+ 0.054	+ 0.120	+ 0.007
					8	+ 0.076	+ 0.087	+ 0.010
R-1	Open Box	29	2.12	Zero	1	+ 0.192	+ 0.037	- 0.008
					2	+ 0.170	+ 0.049	+ 0.003
					3	+ 0.167	+ 0.044	+ 0.004
					4	+ 0.169	+ 0.040	+ 0.003
					5	+ 0.168	+ 0.037	- 0.008
					6	+ 0.184	+ 0.019	- 0.016
					7	+ 0.188	+ 0.028	- 0.018
					8	+ 0.186	+ 0.027	- 0.019
T-3	Hollow Cube	20	1.46	45	1	+ 0.469	- 0.003	+ 0.566
					2	+ 0.458	+ 0.020	+ 0.390
					3	+ 0.448	+ 0.037	+ 0.204
					4	+ 0.446	+ 0.007	+ 0.054
					5	+ 0.438	- 0.022	- 0.081
					6	+ 0.455	- 0.052	+ 0.110
					7	+ 0.456	- 0.074	+ 0.277
					8	+ 0.466	- 0.053	+ 0.417
T-2	Hollow Cube	20	1.46	30	1	+ 0.428	- 0.116	+ 0.469
					2	+ 0.468	- 0.054	+ 0.315
					3	+ 0.419	- 0.034	+ 0.119
					4	+ 0.378	- 0.010	- 0.070
					5	+ 0.352	- 0.067	+ 0.082
					6	+ 0.297	- 0.108	+ 0.237
					7	+ 0.337	- 0.147	+ 0.430
					8	+ 0.375	- 0.183	+ 0.621
T-1	Hollow Cube	20	1.46	Zero	1	+ 0.440	- 0.242	+ 0.473
					2	+ 0.419	- 0.174	+ 0.220
					3	+ 0.407	- 0.090	+ 0.105
					4	+ 0.326	- 0.139	+ 0.052
					5	+ 0.249	- 0.165	+ 0.104
					6	+ 0.252	- 0.231	+ 0.318
					7	+ 0.253	- 0.297	+ 0.532
					8	+ 0.344	- 0.306	+ 0.515

Note: Radius = Distance from center-line of charge to closest point on the target
Radius Scale - λ = Radius X (Weight of Charge) -1/3
CW = Clockwise movement

CONFIDENTIAL SECURITY INFORMATION

FIGURE 20

CONFIDENTIAL SECURITY INFORMATION



SUPPLEMENTARY SKEW STRUCTURES PROGRAM

TARGET MOVEMENTS

RELATIVE TO CENTER LINE OF CHARGE

ROUND S-3

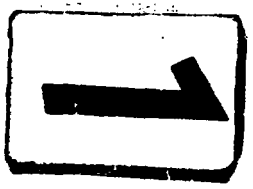
Structure	Type	Radius Feet	Radius Scale λ	Skew Angle Degrees	Rivet No.	Movements - Feet Radial + = Out	Tang. + = CW	Vert. + = Up
R-4	Open Box	23.96	1.75	Zero	1	+ 0.748	- 0.032	+ 0.093
					2	+ 0.694	+ 0.016	+ 0.084
					3	+ 0.698	- 0.017	+ 0.080
					4	+ 0.697	- 0.004	+ 0.076
					5	+ 0.646	- 0.045	+ 0.087
					6	+ 0.707	- 0.100	+ 0.093
					7	+ 0.708	- 0.073	+ 0.098
					8	+ 0.696	- 0.095	+ 0.102
R-7	Open Box	24.08	1.76	30	1	+ 0.623	+ 0.040	+ 0.159
					2	+ 0.544	- 0.083	+ 0.134
					3	+ 0.529	- 0.150	+ 0.108
					4	+ 0.358	- 0.108	+ 0.089
					5	+ 0.335	- 0.106	+ 0.070
					6	Destroyed by detonation		
					7	+ 0.561	+ 0.027	+ 0.122
					8	+ 0.652	- 0.018	+ 0.138
R-6	Open Box	25.00	1.83	Zero	1	+ 0.419	- 0.061	+ 0.115
					2	+ 0.354	- 0.040	+ 0.114
					3	+ 0.364	- 0.061	+ 0.083
					4	+ 0.362	- 0.046	+ 0.053
					5	+ 0.321	- 0.069	+ 0.058
					6	+ 0.342	- 0.091	+ 0.064
					7	+ 0.345	- 0.069	+ 0.088
					8	+ 0.332	- 0.090	+ 0.124
T-7	Hollow Cube	17.46	1.28	45	1	+ 0.475	- 0.958	+ 0.472
					2	+ 0.371	- 0.908	+ 0.365
					3	+ 0.446	- 0.861	+ 0.253
					4	+ 0.372	- 0.901	+ 0.199

					2	+ 0.694	+ 0.016	+ 0.084
					3	+ 0.698	- 0.017	+ 0.080
					4	+ 0.697	- 0.004	+ 0.076
					5	+ 0.643	- 0.045	+ 0.087
					6	+ 0.707	- 0.100	+ 0.093
					7	+ 0.708	- 0.073	+ 0.098
					8	+ 0.696	- 0.095	+ 0.102
R-7	Open Box	24.08	1.76	30	1	+ 0.623	+ 0.040	+ 0.159
					2	+ 0.541	- 0.083	+ 0.134
					3	+ 0.529	- 0.150	+ 0.108
					4	+ 0.358	- 0.108	+ 0.089
					5	+ 0.335	- 0.106	+ 0.070
					6	Destroyed by detonation		
					7	+ 0.561	+ 0.027	+ 0.122
					8	+ 0.682	- 0.018	+ 0.138
R-6	Open Box	25.00	1.83	Zero	1	+ 0.419	- 0.061	+ 0.115
					2	+ 0.354	- 0.040	+ 0.114
					3	+ 0.364	- 0.061	+ 0.083
					4	+ 0.362	- 0.046	+ 0.053
					5	+ 0.321	- 0.069	+ 0.058
					6	+ 0.342	- 0.091	+ 0.064
					7	+ 0.345	- 0.069	+ 0.088
					8	+ 0.332	- 0.090	+ 0.124
T-7	Hollow Cube	17.46	1.28	45	1	+ 0.275	- 0.958	+ 0.472
					2	+ 0.371	- 0.908	+ 0.365
					3	+ 0.446	- 0.861	+ 0.253
					4	+ 0.372	- 0.901	+ 0.199
					5	+ 0.264	- 0.894	+ 0.146
					6	Destroyed by detonation		
					7	+ 0.095	- 0.960	+ 0.328
					8	+ 0.182	- 0.964	+ 0.404
T-6	Hollow Cube	17.58	1.29	30	1	+ 0.866	+ 0.110	+ 0.422
					2	+ 0.747	+ 0.251	+ 0.360
					3	+ 0.733	+ 0.297	+ 0.294
					4	+ 0.748	+ 0.251	+ 0.231
					5	+ 0.792	- 0.201	+ 0.165
					6	+ 0.862	- 0.091	+ 0.198
					7	+ 0.918	+ 0.040	+ 0.251
					8	+ 0.921	+ 0.063	+ 0.366
T-5	Hollow Cube	18.50	1.35	Zero	1	+ 0.736	+ 0.944	+ 0.417
					2	+ 0.677	+ 0.830	+ 0.325
					3	+ 0.961	+ 0.840	+ 0.444
					4	+ 0.545	+ 0.838	+ 0.172
					5	+ 0.466	+ 0.901	+ 0.184
					6	+ 0.369	- 0.959	+ 0.182
					7	+ 0.347	- 0.973	+ 0.259
					8	Destroyed by detonation		



Note: Radius = Distance from center-line of charge to closest point on the target
Radius Scale - Λ = Radius X (Weight of Charge) -1/3
CW = Clockwise movement

FIGURE 21



[illegible] SUBSURFACE SOILS INVESTIGATION

FIELD SOIL TESTS

Target No.	Location	Depth Below Grade From	Depth Below Grade To	Field Moisture %	Yield Densities - lbs. per Cu. Ft. Wet Wt.	Dry Weight Natural	Dry Weight Backfill	Dry Weight After Blast
				BLIND #2				
T-1	Center of Target	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
	" " "	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
	" " "	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	-
	Back " "	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
	10' " " "	[illegible]	[illegible]	[illegible]	99.3	-	-	[illegible]
T-2	Center of Target	1.2	1.8	10.8	97.1	[illegible]	-	-
	" " "	1.2	1.9	9.9	96.3	[illegible]	-	-
	" " "	5.1	5.8	15.9	91.7	79.1	-	-
	In Front of Target	5.4	6.1	12.6	94.1	-	[illegible]	-
	15' Back " "	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
T-3	Center of Target	1.2	1.8	10.5	[illegible]	89.5	-	-
	" " "	[illegible]	6.2	14.4	[illegible]	86.4	-	-
	In Front of Target	[illegible]	5.7	14.8	96.1	-	[illegible]	-
	Back "	4.	[illegible]	13.2	[illegible]	-	-	[illegible]
T-5	Center of Target	1.[illegible]	1.9	9.1	[illegible]	102.8	-	-
	" " "	[illegible]	[illegible]	17.1	[illegible]	[illegible]	-	-
	45' Back " "	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
	In Front of Target	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
T-1	Center of Target	[illegible]	1.9	[illegible]	[illegible]	[illegible]	-	-
	" " "	[illegible]	6.9	11.4	[illegible]	[illegible]	-	-
	Front " "	[illegible]	4.7	11.9	101.8	[illegible]	89.1	-
	" " "	[illegible]	1.8	10.8	98.1	-	[illegible]	-
	[illegible]' Back " "	[illegible]	[illegible]	[illegible]	94.4	-	-	[illegible]
	Left " "	[illegible]	[illegible]	[illegible]	91.7	-	-	[illegible]
T-2	Center of Target	1.8	1.9	9.7	[illegible]	[illegible]	-	-
	" " "	[illegible]	6.9	[illegible]	[illegible]	[illegible]	-	-
	Front " "	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	-
	" " "	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	-
	Right " "	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
	15' Back " "	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
T-3	Center of Target	1.8	1.9	9.3	95.6	[illegible]	-	-

CONFIDENTIAL
SECURITY INFORMATION

FIGURE 22

T-1	Center of Target	1.4	1.3	7.6	98.4	91.7	-	-	
	" " "	4.4	4.3	11.0	94.1	76.5	-	-	
	Front " "	1.4	1.3	11.9	101.3	-	88.1	-	
	" " "	4.4	4.4	11.8	94.1	-	84.0	-	
	31' Back " "	1.4	1.3	11.1	94.1	-	-	84.0	
	Left " "	4.4	4.3	9.6	91.7	-	-	82.0	
T-2	Center of Target	1.3	1.3	9.7	97.4	88.2	-	-	
	" " "	4.4	4.3	12.1	94.1	78.4	-	-	
	Front " "	4.4	4.3	11.7	94.1	-	84.0	-	
	" " "	4.4	4.3	11.6	96.2	-	84.0	-	
	Right " "	4.4	4.3	11.2	96.2	-	-	84.0	
	31' Back " "	4.4	4.3	10.9	91.7	-	-	84.0	
T-3	Center of Target	1.4	1.4	7.3	98.4	89.1	-	-	
	" " "	4.4	4.3	12.0	94.1	78.4	-	-	
	Right " "	1.4	1.4	9.8	101.9	89.1	-	-	
	Front " "	1.4	1.4	12.3	89.1	-	76.3	-	
	Left " "	4.4	4.4	13.2	96.4	-	-	84.0	
	31' Back " "	4.4	4.3	11.7	89.8	-	-	84.0	

BOARD S-3

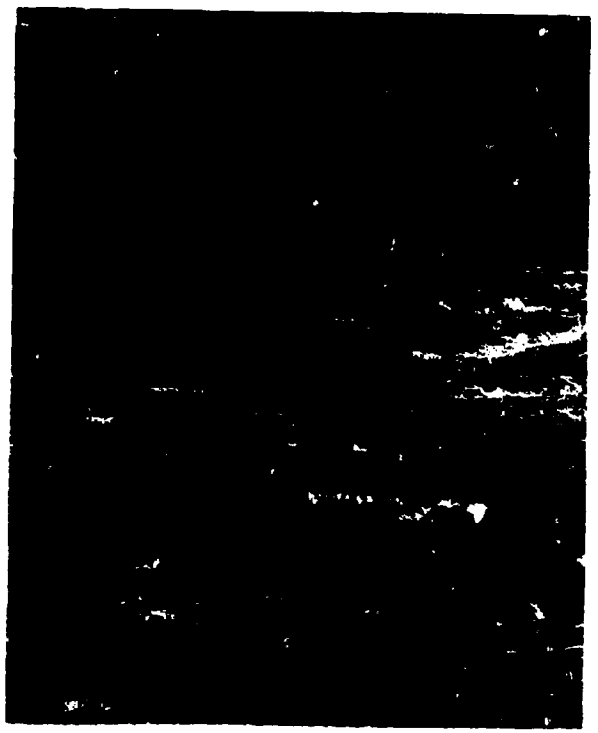
T-5	Center of Target	1.4	1.4	7.9	91.7	85.6	-	-	
	" " "	4.4	4.4	13.0	79.9	70.7	-	-	
	Front " "	1.4	1.4	10.1	89.2	-	81.0	-	
	" " "	4.4	4.4	13.9	86.6	-	74.8	-	
	Left " "	4.4	4.4	10.2	79.2	-	-	77.4	
T-6	Center of Target	1.4	1.4	7.9	99.8	92.5	-	-	
	" " "	4.4	4.4	11.6	74.6	62.9	-	-	
	Front " "	1.4	1.4	10.4	89.7	-	81.3	-	
	" " "	4.4	4.4	11.4	92.4	-	80.3	-	
	Left " "	4.4	4.4	**14.8**	**96.0**	-	-	83.6	
T-7	Center of Target	1.4	1.4	7.6	87.8	81.4	-	-	
	Front " "	1.4	1.4	10.2	86.4	-	78.2	-	
	" " "	4.4	4.4	13.7	94.9	-	84.0	-	
	31' Back " "	4.4	4.6	11.8	86.1	-	-	77.4	
	32' " " "	4.4	4.6	9.9	106.6	-	-	96.2	
R-6	Center of Target	1.4	1.6	8.7	92.4	85.8	-	-	
	" " "	4.4	4.6	15.4	87.6	75.9	-	-	
	Front " "	4.4	4.6	13.3	94.3	-	83.3	-	
	32.5' Back " "	4.4	4.6	15.0	89.3	-	-	77.7	
R-7	Center of Target	1.4	1.6	8.0	90.6	83.9	-	-	
	" " "	4.4	4.6	13.8	79.4	70.3	-	-	
	" " "	4.4	4.6	16.3	77.3	66.5	-	-	
	Front " "	4.4	4.6	13.4	90.6	-	79.9	-	
R-4	Center of Target	1.4	1.6	7.9	85.7	79.4	-	-	
	" " "	4.4	4.5	10.5	79.5	71.9	-	-	
	Front " "	4.4	4.6	10.4	94.7	-	85.8	-	
	31' Back " "	4.4	4.6	13.3	79.3	-	-	72.0	
	32.5' " "	4.4	4.6	15.7	86.5	-	-	74.8	

CONFIDENTIAL
SECURITY INFORMATION

2



Targets prepared for detonation.



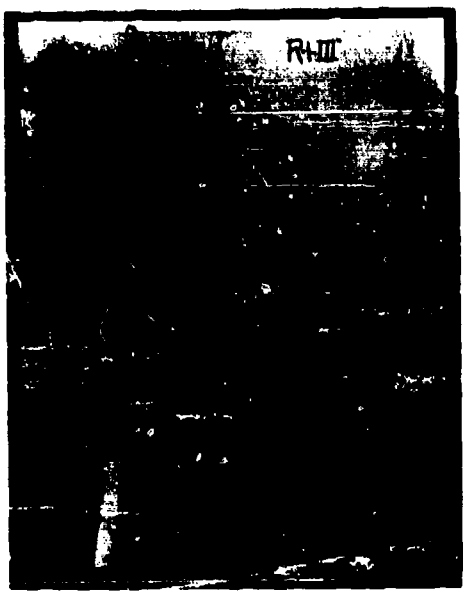
Crater.



Detonation.



Crater.



R-1-IV
No Visible Cracks



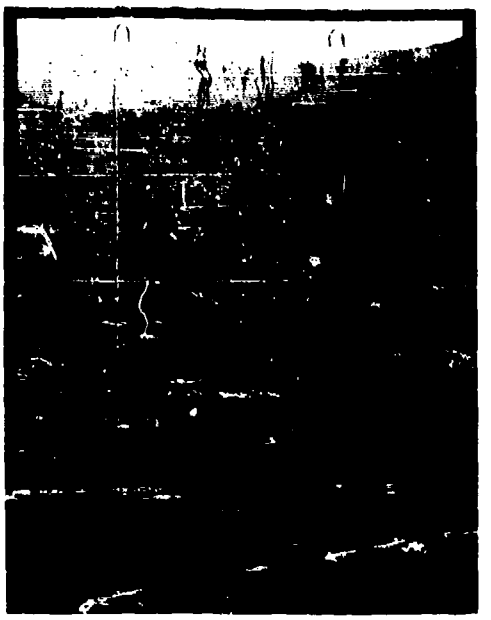
1



R-1-III
No Visible Cracks

Supplementary Skew Structures Program.

R-1-IV
No Visible Cracks

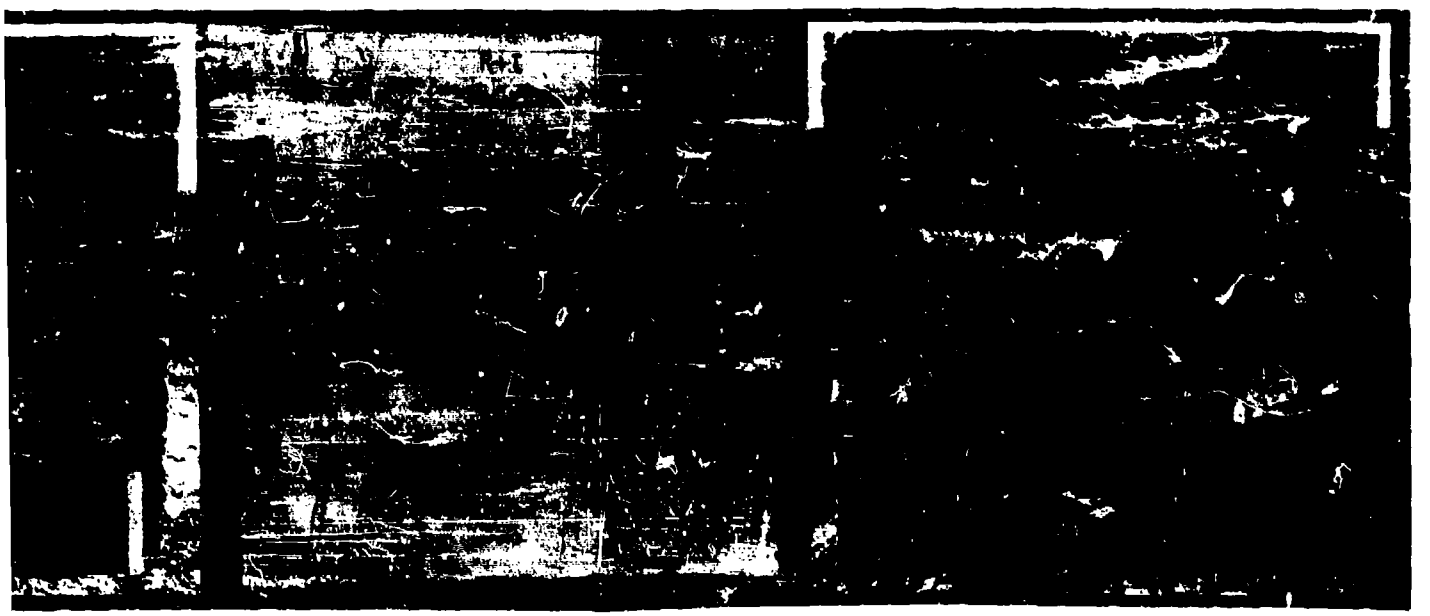


R-1-II
No Visible Cracks

2

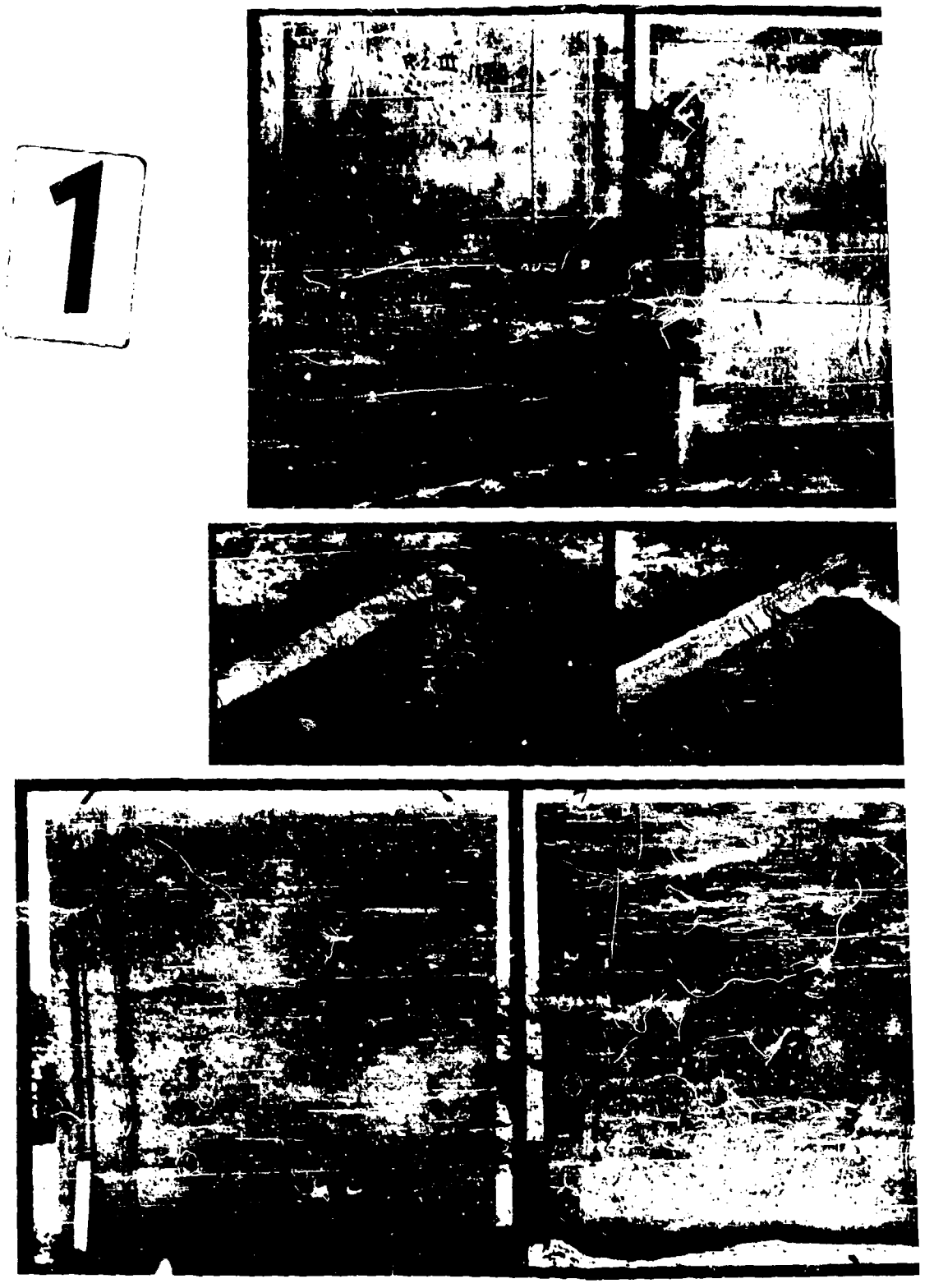




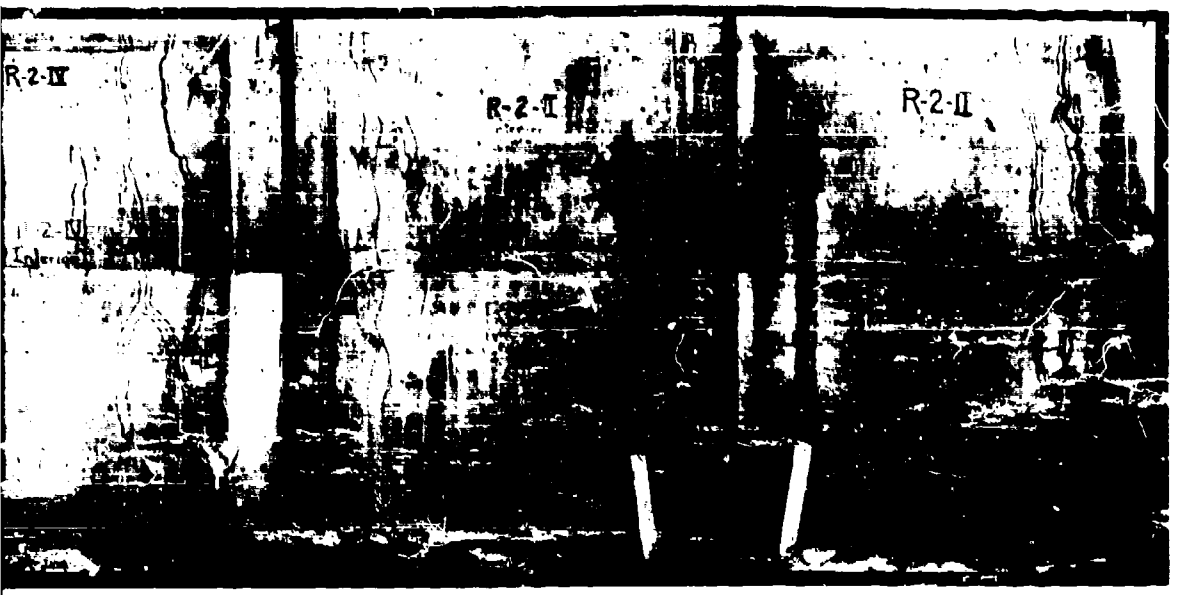


Navy Shock Structures Program.

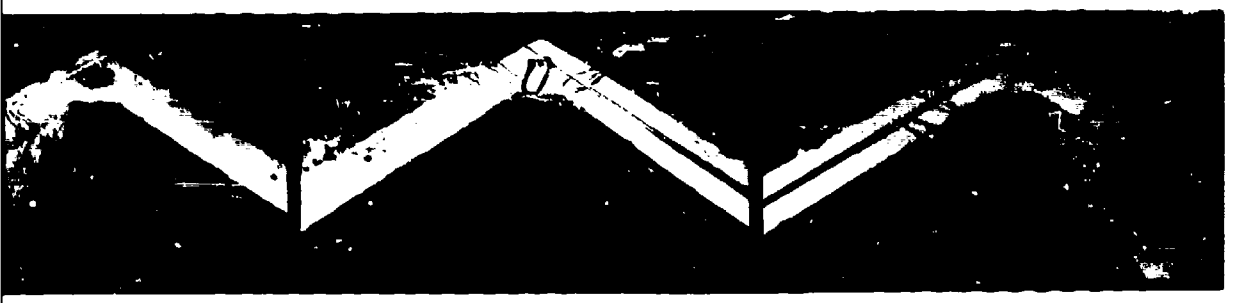
CONFIDENTIAL - SECURITY INFORMATION
Round 3-2 Target R-1 Photo No. 3



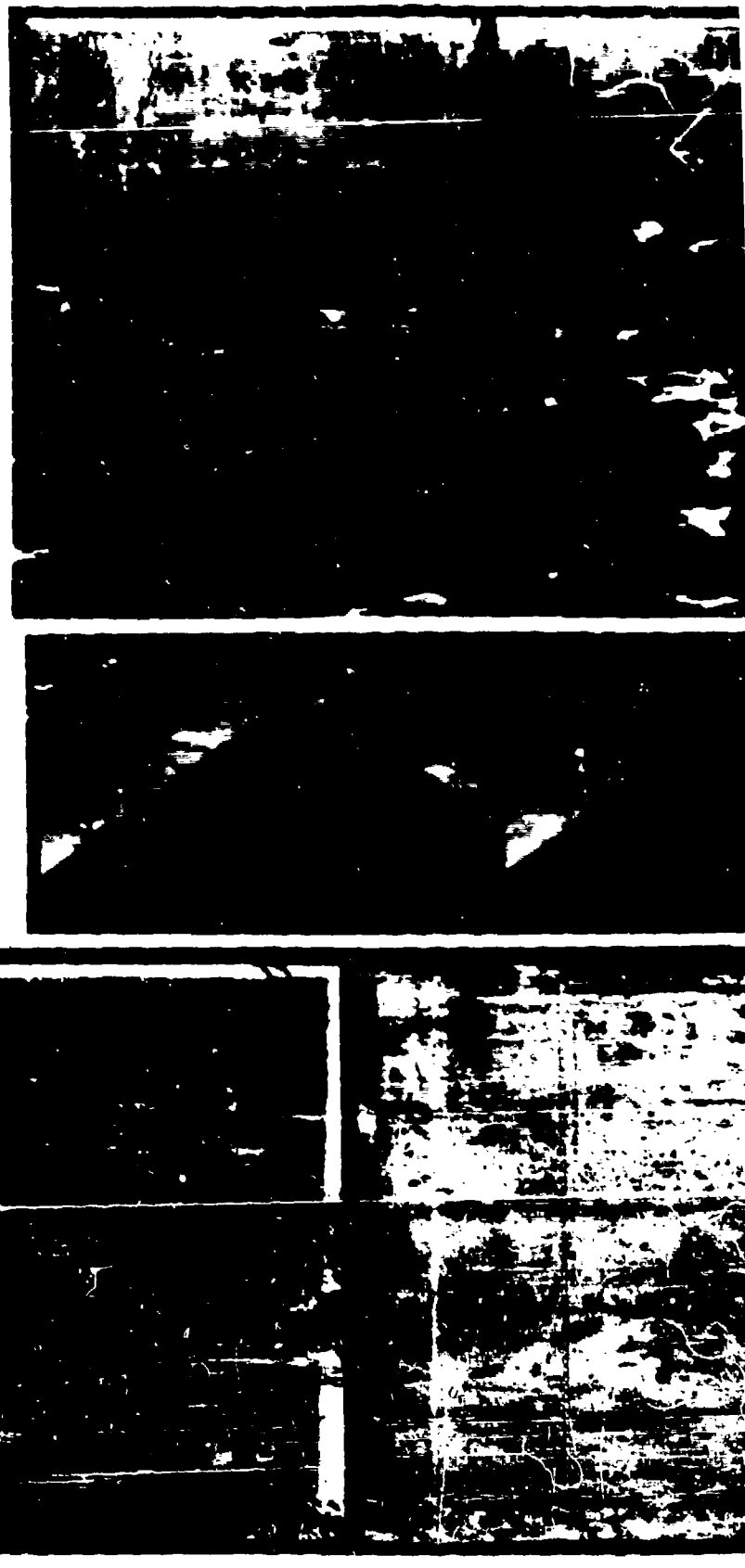
Supplementary Si



2







1

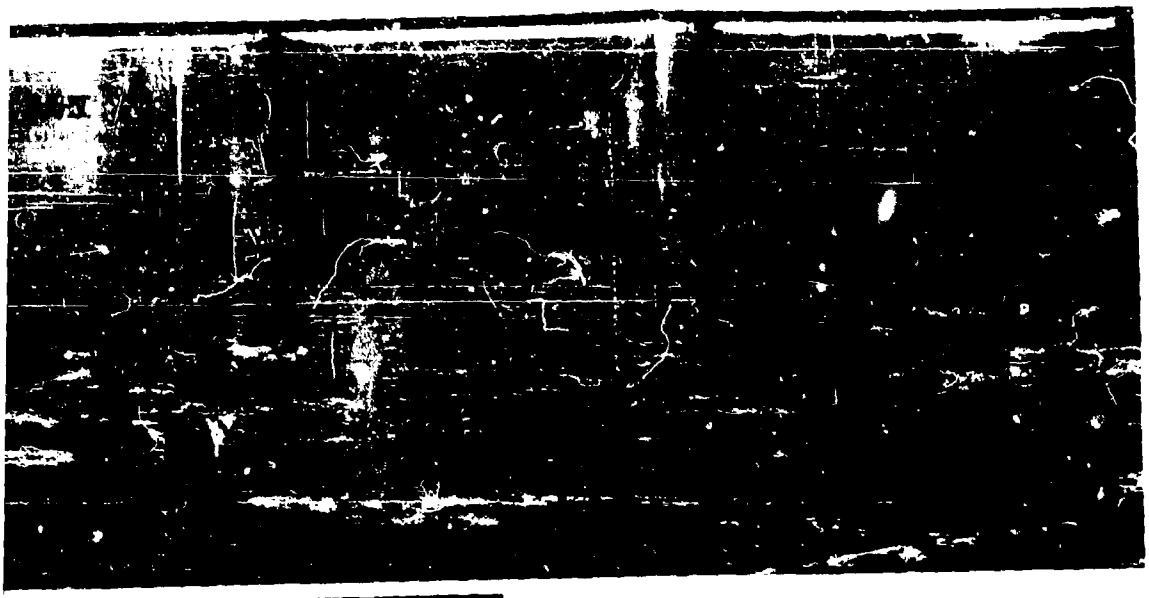
2



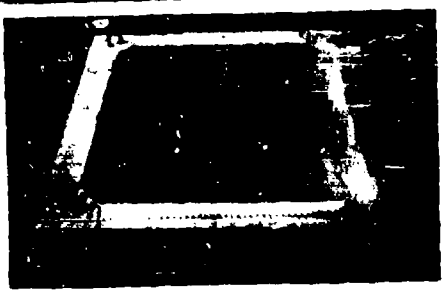


Operation Nougat Shock Structures Program.

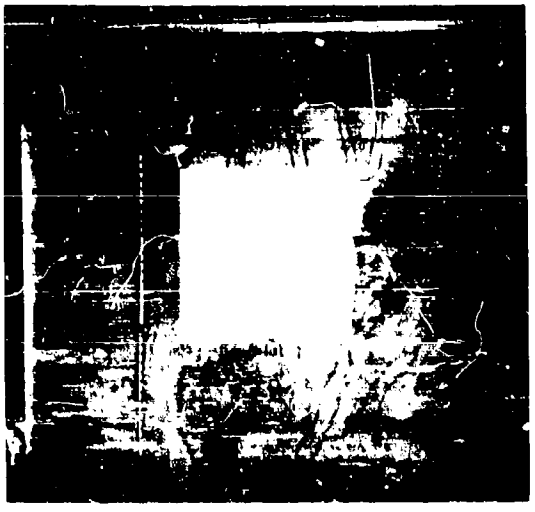
CONFIDENTIAL - SECURITY INFORMATION
Round S-2 Target R-3 Photo No. 5

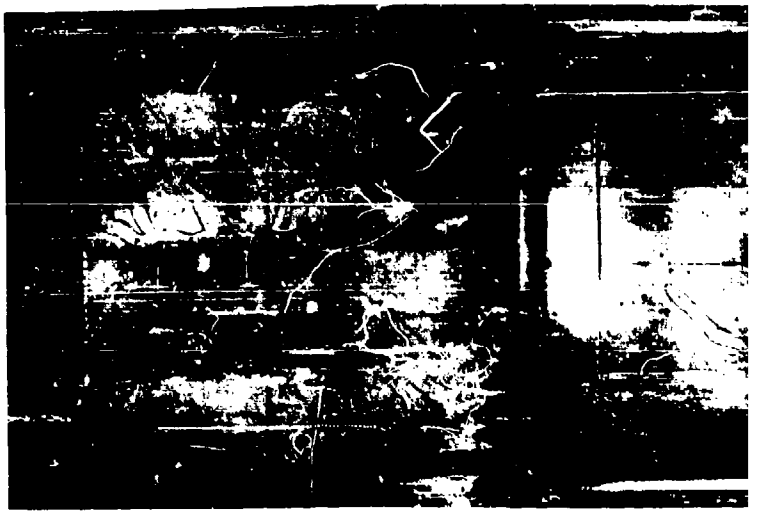


2

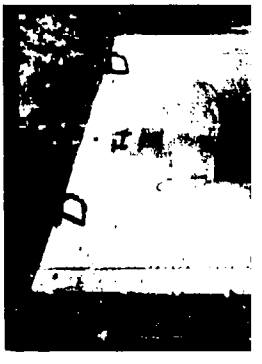






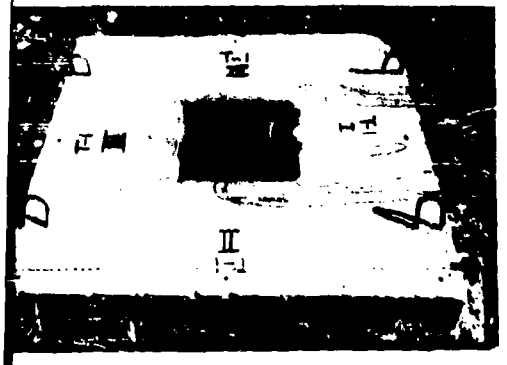




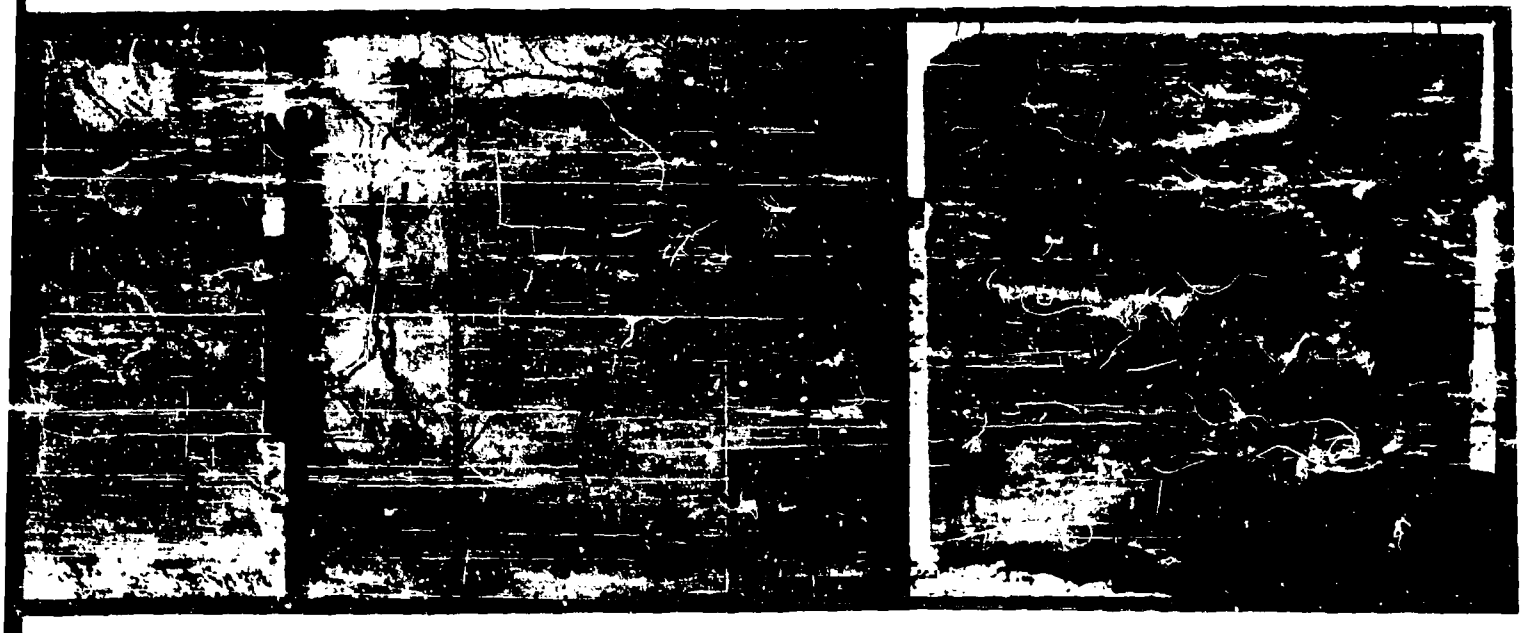








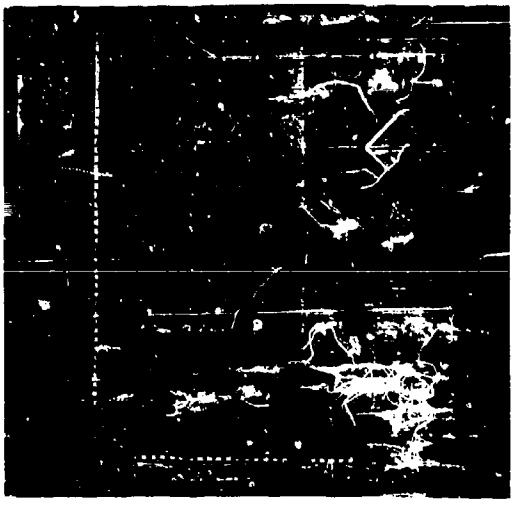
2



Sgt Leonard Sea Street Test Program.

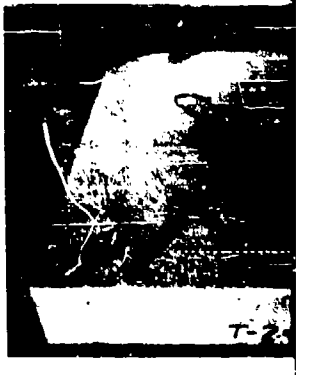
CONFIDENTIAL -- SECURITY INFORMATION
Round 3-2 Target 2-1 Photo No. 2

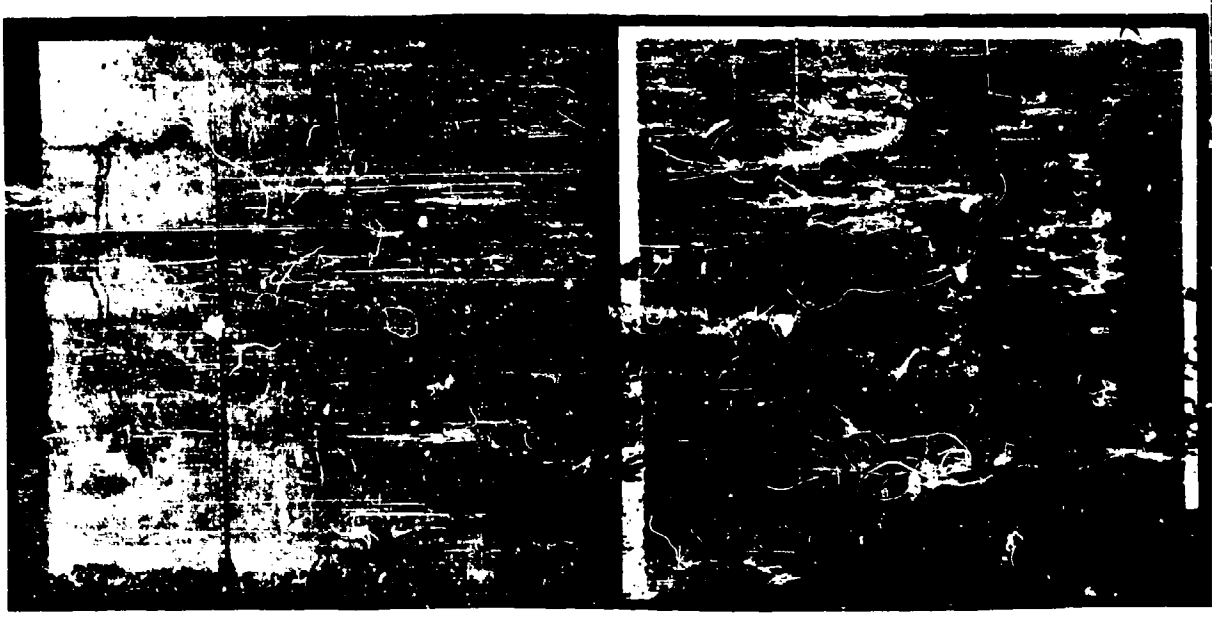




No Visible

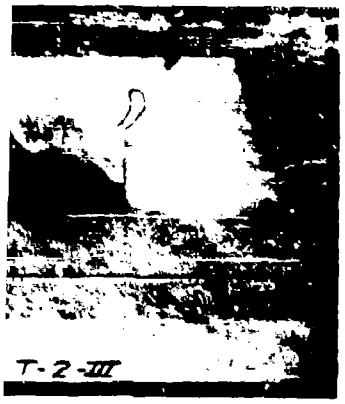






Supplementary Skew St









T-2-I
No Visible Cracks

T-2-IV
No Visible Cracks

Navy Submarine Program.

1







2

Fig. 2
No Visible Cracks

Fig. 2
No Visible Cracks

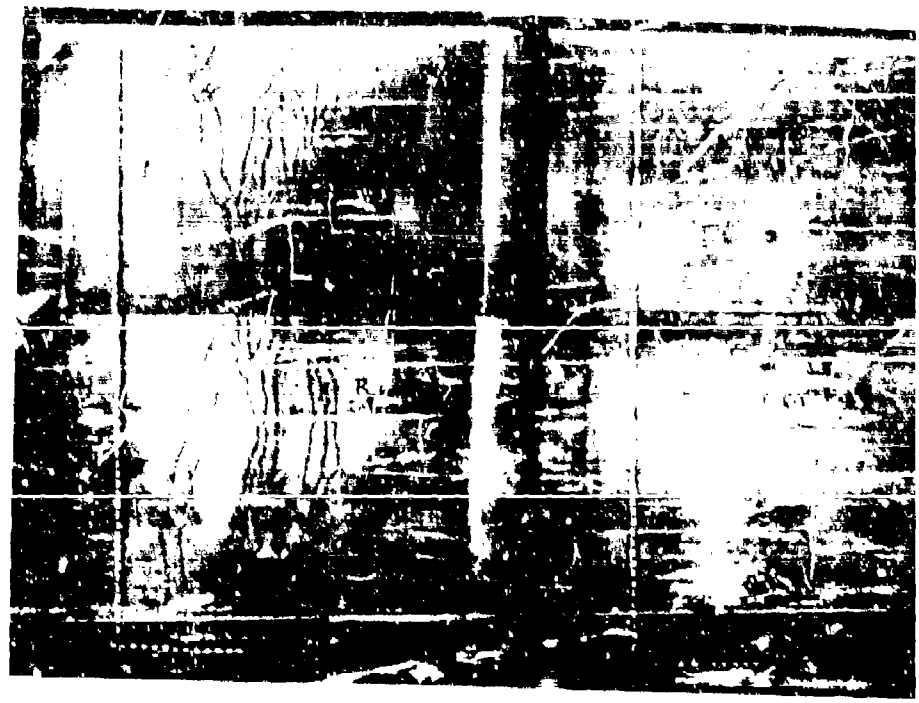


1



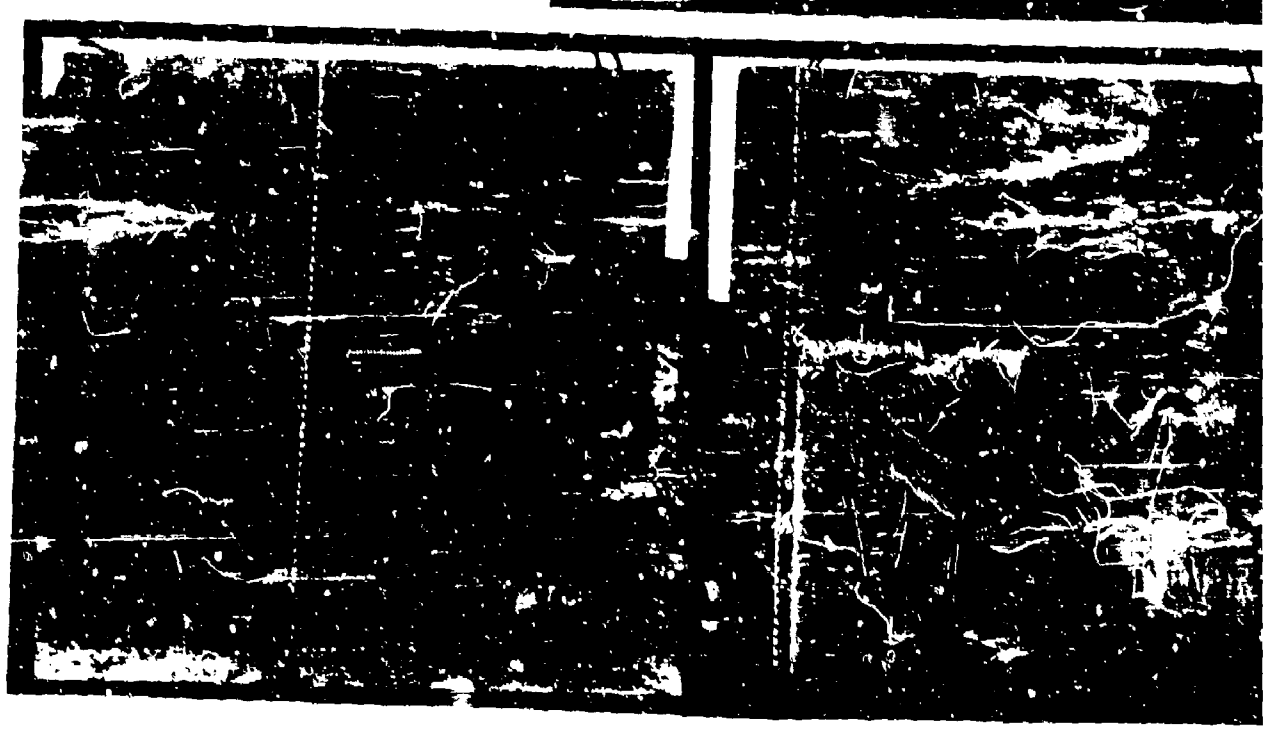


2



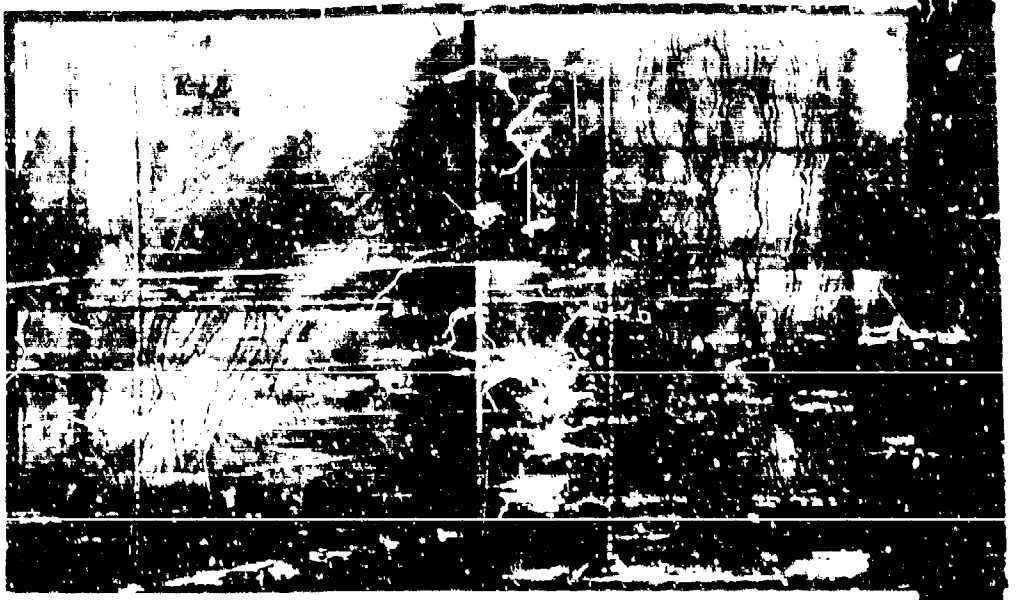
1



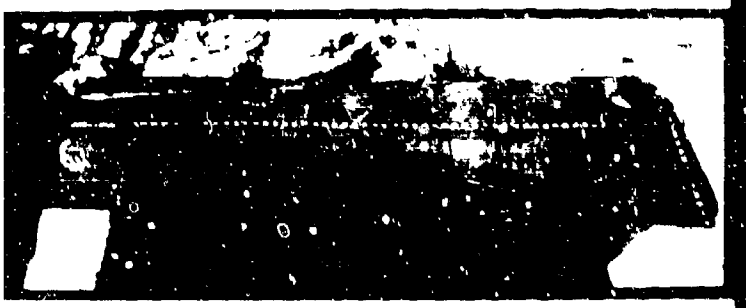


1

2

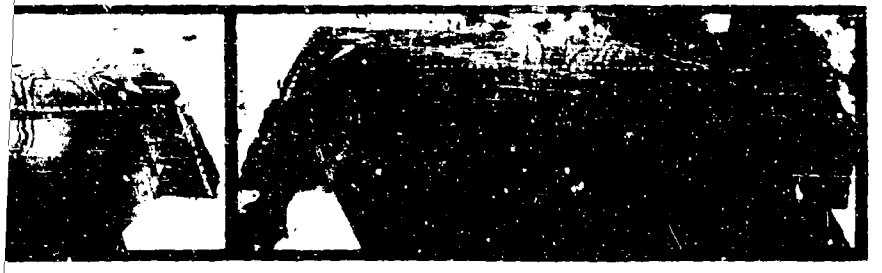


1







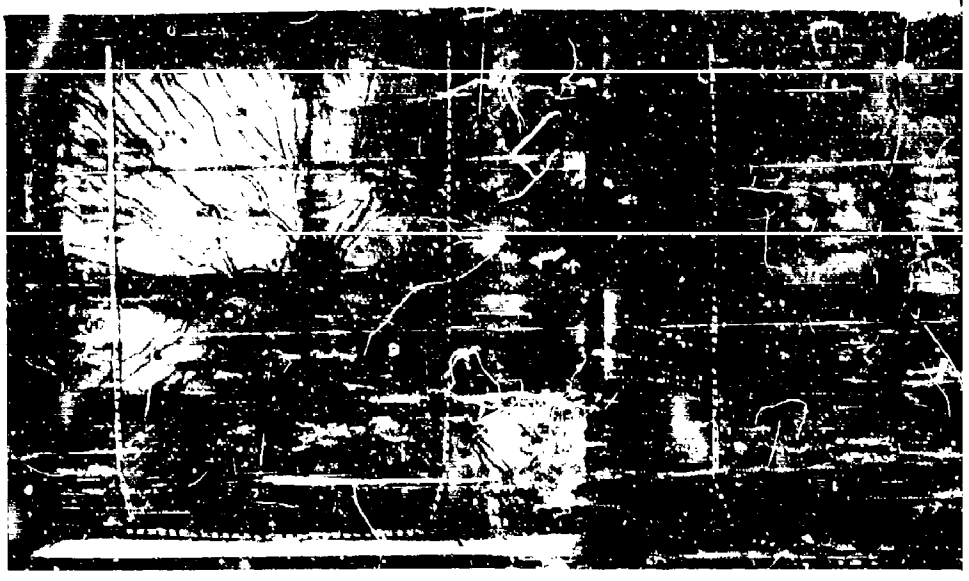




2

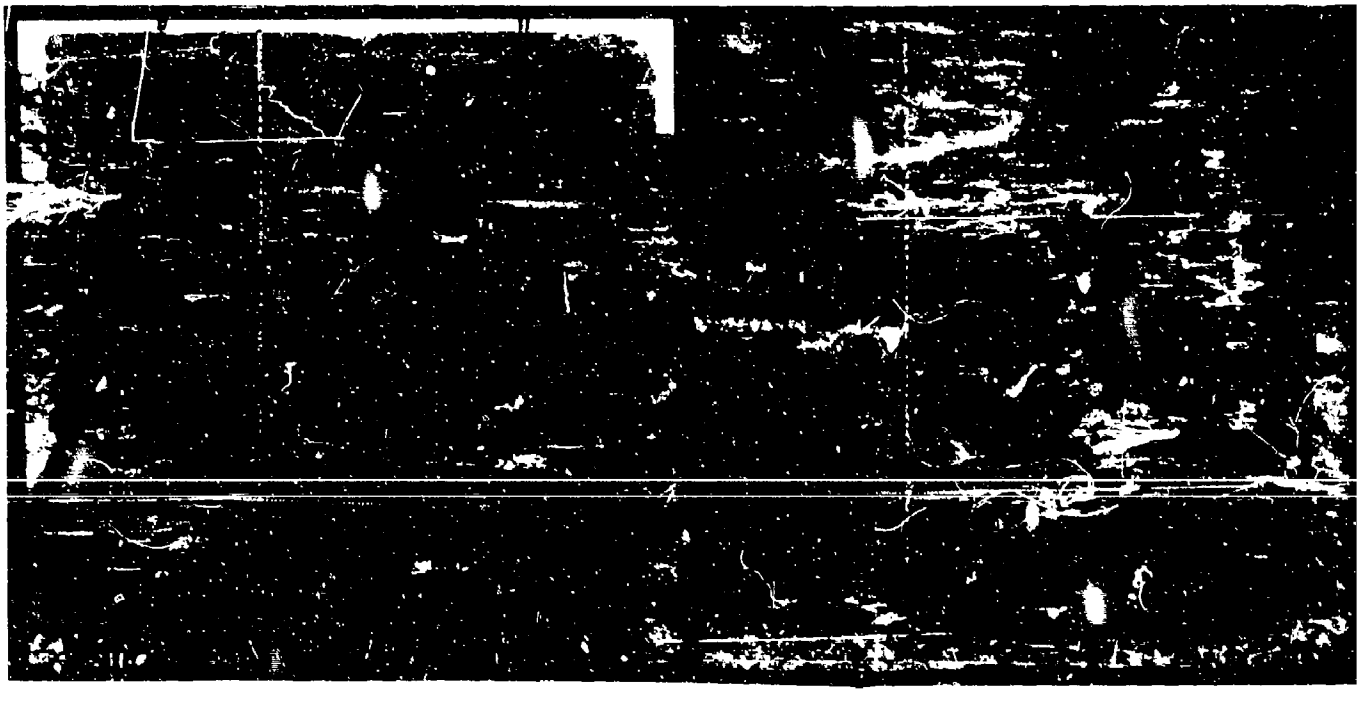
CONFIDENTIAL - SECURITY INFORMATION
Round S-3 Page 5, S-7 Photo No. 12









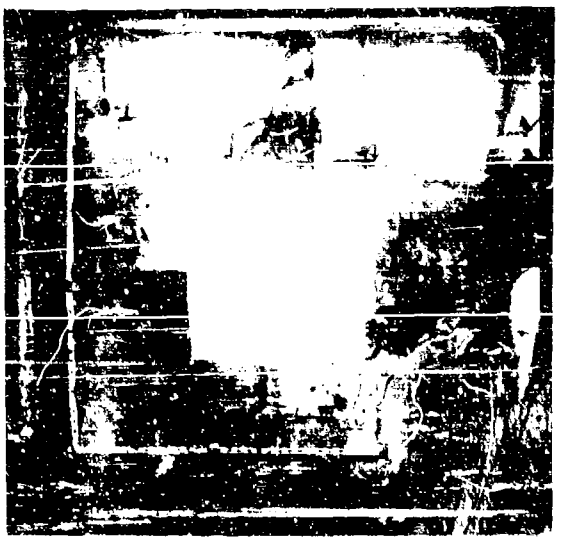






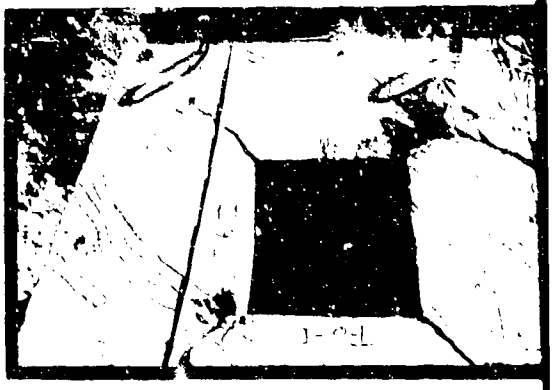
2

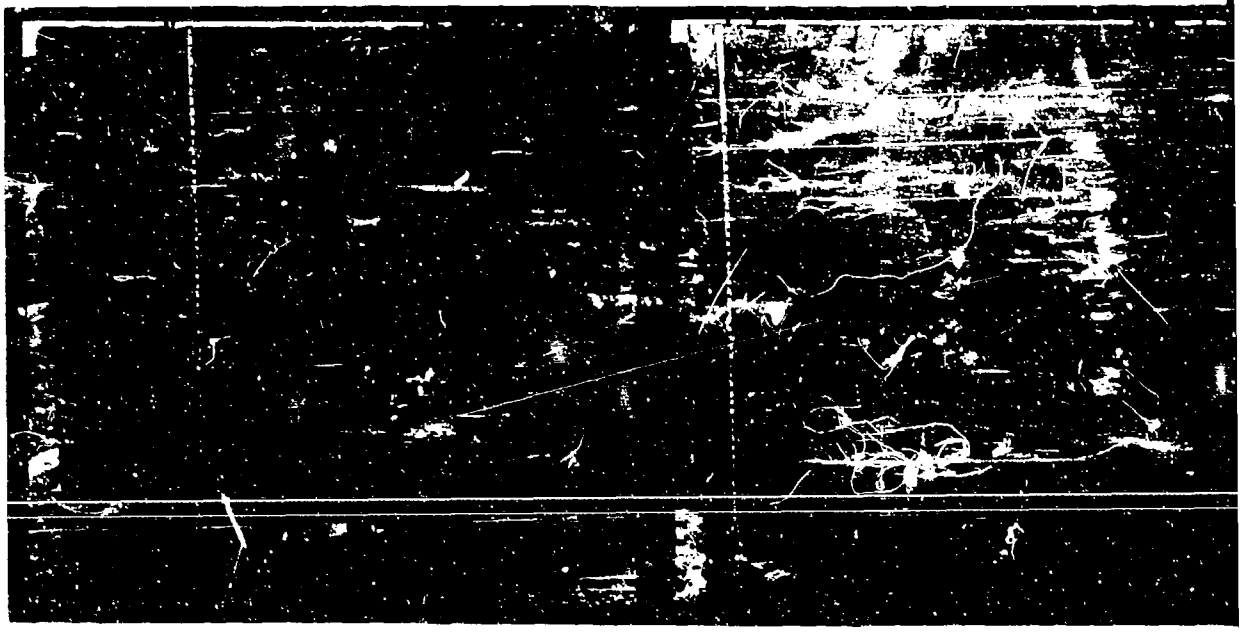










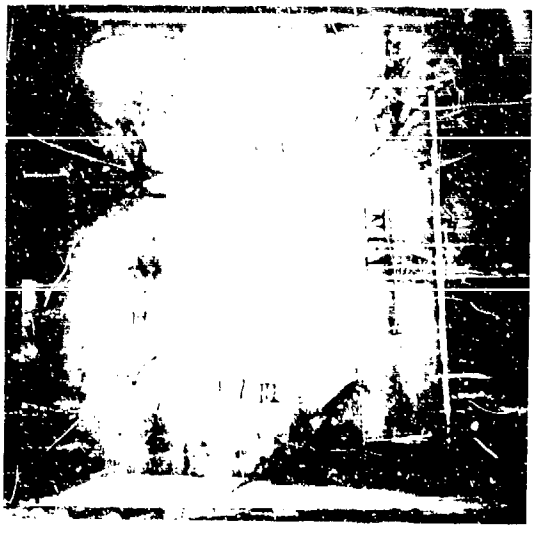






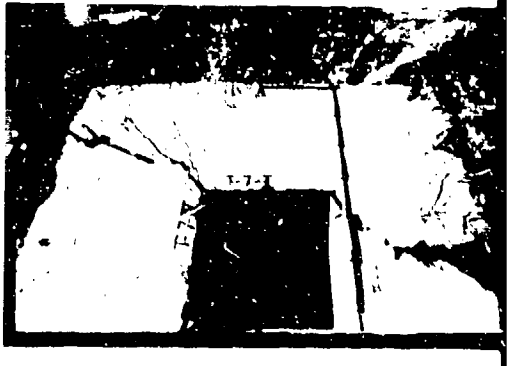
2



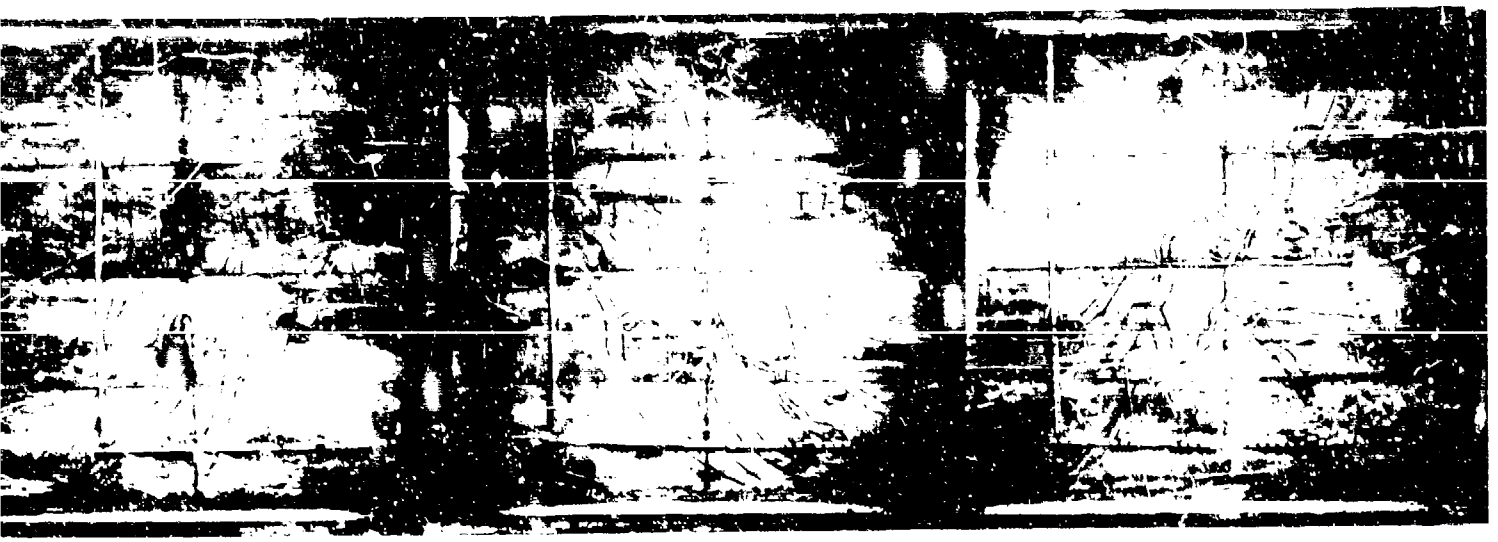




1

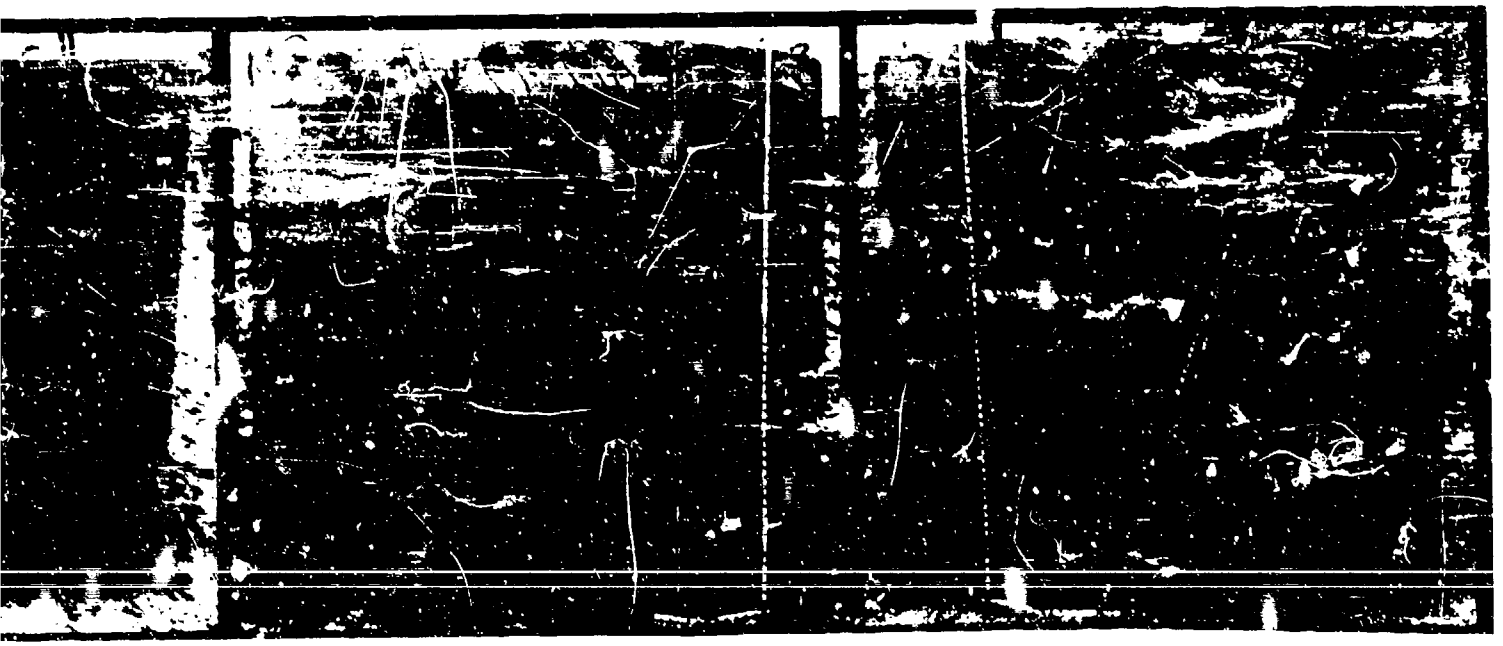








2



UNCLASSIFIED

UNCLASSIFIED